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EDITORIAL

THIS year the Summer meeting of the Institution of Mining Engineers is to be held in Nottingham from July 19 to 21 at the invitation of the President and Council of the Midland Counties Institution of Engineers. Headquarters for the meeting will be in the University of Nottingham. The usual series of interesting visits has been arranged.

AT the Second International Materials Handling Conference to be held at Southport from May 10 to 12 problems to be discussed are to be divided into four main groups. Included in one of these will be a talk on handling in tin mining which will be given by Mr. J. L. Farrington, chairman of A.O. Nigeria, Ltd., the managers of Amalgamated Tin Mines of Nigeria. The conference is organized by the Institute of Materials Handling.

A SECOND Effluent and Water Treatment Exhibition and Convention to be held at the Seymour Hall from October 31 until November 3 this year will, it is stated, be a third larger than the first show held in the same hall last year. This growth reflects communal and industrial expansion and comprises two complementary divisions. The first is the water treatment industry, while the second division consists of that, once embryonic, industry which sprang into life following the Rivers (Prevention of Pollution) Acts of 1951. The exhibition should, therefore, meet the ever-increasing demands for information and guidance on industrial water and effluent treatment and to satisfy these demands the show will also include convention papers from overseas experts in effluent and water treatment.

IT is now reported that Hunting Surveys, Ltd., has completed the aerial photography of 11,000 sq. miles of Uganda under a Colonial Development and Welfare Scheme. The area covered extends to the south and east of Lake Albert. Field parties from the Directorate of Overseas Surveys are at the moment establishing ground control for the air survey from which 1/50,000 scale contoured maps of the area will be made. Although good progress has been made with Uganda mapping this wide belt of country between Lake Albert and the railway that runs from Kampala to the Kilembe copper mine on the flanks of Ruwenzori has not yet been covered by basic, medium-scale mapping. The new 1/50,000 series will, therefore, be of the utmost use to the Government departments, commissions, and the general public for all types of agricultural, commercial, or industrial development no matter what the future political structure of the country may be. The steady programme which is thus being pursued is the essential pre-requisite for planned economic development.

WITH prices for zinc and lead remaining at their present low levels, particularly that for lead, it can be noted with interest that " Lead's New Frontiers " is to be the theme of the 33rd annual meeting of the Lead Industries Association to be held in Chicago in May. One session will be devoted to " developments that are keeping lead abreast of the rapid pace of modern technology," while another will review the " substantial " progress being made in the case of the Association's own research programme and its search for new markets and products. Also to be described will be the educational, advertising, and technical service programme of the lead industry. The opening session will be held jointly with the American Zinc Institute and will include papers of broad interest to both industries on national and international developments and the general economic outlook.

AN announcement by the Society of Mining Engineers in the United States is to the effect that it is to commemorate the 50th anniversary of froth flotation in America with a special programme. A meeting is to be held in Denver, under the auspices of the Minerals Beneficiation Division of the American Institute, from September 17 to 20 next. The occasion is to be signalized by the

publication of an anniversary volume. There will be six technical sessions of five papers each, covering those theories, practices, and developments of real purpose which are not already classed as proved and accepted in the science of froth flotation. The session themes are to be: Flotation and Promotor and Depressor Action; Mechanics and Kinetics of Flotation; Present Flotation Practice; Overall Milling-Circuits Design and Effects on Mining and Smelting; Flotation Mill Control, and Preparation of Ore and Minerals for Flotation. The papers are to be preprinted by the Colorado School of Mines and available for the symposium sessions. The anniversary volume, as distinguished from the symposium papers, is a comprehensive reference work and is being compiled by Dr. Douglas W. Fuerstenau, Associate Professor of Metallurgy at the University of California in Berkeley.

A New Look at Australian Mineral Resources

Elsewhere in this issue a correspondent in Western Australia takes a look at mineral potentialities in the State and indicates a likelihood of interesting developments. However, it is not in Western Australia alone that new stock is being taken, since the Commonwealth as a whole has awakened to lively possibilities. In the course of a review in the latest number of the "Quarterly Review of the Australian Mineral Industry" the Minister for National Development, the Hon. W. H. Spooner, expresses the view that the mineral industry in Australia is likely to continue to develop quite strongly "in spite of some year-to-year fluctuations in the level of activity." While domestic supplies of raw materials remain adequate there are certain instances where resources are lacking or cannot at the moment be economically developed, the principal deficiency being, of course, oil. The discovery of domestic oil supplies would be the most important single break-through in the development of the mineral industry. Otherwise, the Minister thinks, the general picture for the future is one of steady expansion in production of a wide range of mineral products, with the possibility of notable developments in a few instances, which include the exploration for and development of new iron-ore deposits, which should be stimulated by the Government's recent decision to permit export of iron-ore subject to certain conditions. There should also be increased production of coal, with the opportunity for developing export markets as a result of mechanization in the coal-mining industry, and continued exports of copper, with increased production from Mount Isa in the long term. For the base metals increased refining capacity is available and the development of the bauxite-alumina-aluminium industry based on the bauxite deposits of Northern and Western Australia opens up an exciting future.

The Minister emphasizes that the major factors stimulating mineral production over the past decade have been the demands of expanding secondary industry, particularly iron and steel, engineering, chemicals, and construction materials. These have meant an increased demand for fuel and power. At the same time the export market has also stimulated increased mineral production by Australia.

As regards particular minerals attention is drawn to the considerable increase in the production and exports of black coal and to the fact that the copper content of exports of concentrates in the first ten months of 1960 amounted to 29,800 tons, a substantial increase on total exports for 1959 (20,000 tons). In the same period of 1960 11,200 tons of refined copper and 500 tons of blister were exported. A fall in blister exports results, it is pointed out, from the commencement of refining at Townsville in 1959. Mine production of lead continued to fall and the total production for 1960 is expected to be of the order of 300,000 tons. The output of zinc in the period from January to October, 1960, totalled 240,000 tons, a substantial improvement on the rates for 1958 and 1959. The year's production should not be far short of the previous peak of 291,500 tons (in 1957). Production of refined zinc for the year should be close to 120,000 tons, a new record. Finally, there was a sharp fall in the mine production of tin in the second quarter of 1960, owing to the Tableland Tin dredge being out of commission. That dredge was recommissioned in late August, but drought conditions forced suspension of operations early in November. The output of refined tin will be affected by the reduced availability of concentrates; production for the nine months to the end of September, 1960, was 1,652 tons. Domestic manufacture of tinplate continues to increase and consumption of tin is rising; as a result a higher rate of imports is to be expected.

Ghana State Mining Board

Arrangements in the process of negotiation between the Ghana Government and certain of the gold-mining companies in that country were briefly reviewed in the February issue. In the present month particulars have become available regarding the composition of what is to be known, apparently, as the Ghana State Mining Corporation. This is to be a holding company for the shares of the five gold mines which the Government has offered to buy. As already noted, the Corporation is not to run the mines but to direct overall policy under guidance from the Government.

The Corporation is to be composed of a Board of seven directors, together with 50 workers made up of ten from each of the five companies. These are to be associated with the management of the mines " in a purely consultative and advisory capacity."

The chairman of the Corporation is the Hon. E. Ayeh-Kumi, who is also executive director of the Ghana Development Secretariat. Other directors are: Sir Charles Tachie-Menson, director of the Ariston and Ghana Main Reef mines; Mr. Mark Botsio; Mr. D. K. Foevie; Mr. H. P. Hinchcliffe; Mr. F. Clelland, consulting engineer to the Western Selection group of mines in Ghana, now to be taken over, and the Director of the Geological Survey, Mr. D. A. Bates.

Granite Below the Pennines

In the MAGAZINE for June last attention was drawn to the fact that the Research Grant Committee of the Department of Scientific and Industrial Research had made available a special grant of £36,050 to Durham University to enable the sinking of a bore-hole at Rookhope, in Co. Durham, to investigate the deep structure of the Pennines. Professor K. C. Dunham, who had charge of the programme, was able to site the hole over a gravity low discovered in the course of a geophysical survey carried out by Dr. M. H. P. Bott and Dr. D. Masson-Smith. That survey suggested that a granite stock might be present at about 3,000 ft., with a possible maximum of 5,000 ft. It has been thought that a granite of Tertiary or Hercynian age might well be responsible for the mineralization in the Pennine ore fields and that a deep boring could well show whether in fact granite had intruded the foundation rocks. Such an occurrence could have settled many controversies regarding mineral genesis, although some observers have expressed the view that any granite discovered might be much older.

To some extent curiosity will have been satisfied, since at the meeting of the Geological Society of London earlier this month Professor Dunham was able to announce that the hole planned, as already noted, for a minimum depth of 3,000 ft. had penetrated a granite at 1,281 ft. It seems certain, however, that many problems remain, as the rock discovered is almost certainly of a much greater age than had been thought likely. However, it is welcome news that the bore is to be continued and future results will be awaited with enhanced interest.

Tanganyika's Mineral Exports

Preliminary figures available from Dar es Salaam show that 1960 was likely to constitute a record for Tanganyika Territory, with total mineral exports valued at approximately £7,200,000—an increase of nearly £390,000 over the preceding year. It seems that exports of tin ore were doubled and that there were noteworthy increases in the exports of salt, lead concentrates, mica, gold, and diamonds, although in the case of diamonds, production was somewhat lower in the year. However, in December, exports in respect of diamonds, mica, salt, and tin were considerably higher than in the corresponding month of 1959.

The total value of mineral exports during 1960 was made up as follows: Diamonds, £4,652,800 (1959, £4,547,737); refined gold, £1,231,408 (£1,067,218); lead concentrates, £1,000,000 (£959,357); salt, £124,031 (£114,679; tin concentrates, £106,906 (£50,728); sheet mica, £79,391 (£52,781); crude gypsum, £8,875 (£14,446); refined silver, £7,616 (£7,511); garnet, £5,320 (£11,765); copper ore, £1,626 (£2,864); lime, £1,484 (£886); magnesian bentonite, £809 (£255); kaolin, £790 (£437); meerschaum, £561 (£699); graphite, £380 (£405), and magnesite, £294 (£203). It should be noted that provisional values are given in the case of diamonds, lead concentrates, meerschaum, sheet mica, and tin concentrates, pending the receipt of sales accounts or of valuations. The gold exported realized an average price of £12 13s. 5d. per fine oz. during December, as compared with £12 13s. 1½d. in November, but there was a slight decrease in the average price of silver at 79⅜d. per fine oz.

MONTHLY REVIEW

Introduction.—At the time of writing, with the Conference of Commonwealth Prime Ministers in session, there is a degree of uneasiness as to the course events are likely to take in Africa, as well as uncertainty regarding the position of sterling with regard to revaluation of the Deutschmark and the guilder. While tin prices continue firm and copper marks time, the lead and zinc markets remain quiet.

Transvaal.—The output of the mines on the Rand in January totalled 1,785,614 oz., making with 34,407 oz. from outside producers a total of 1,820,021 oz. for the month. At the end of the month there were 384,816 natives at work in the gold mines, as compared with 364,407 at the end of 1960.

It is reported from Natal that an underwater pipeline for waste chemical disposal is to be installed at the titanium plant under construction near Amanzimtoti, near Durban, by S.A. TITAN PRODUCTS (PTY.), LTD. The mile long 8-in. diameter pipeline is to be made up of rubber-lined concrete pipes manufactured in the Transvaal. It will be laid by a fleet of three barges and a twin-screw diesel tug. They will be in 30-ft. lengths and will be coated with a bitumen and fibreglass wrapping with a concrete reinforced lining and then joined into 300-ft. lengths.

The accounts of MESSINA (TRANSVAAL) DEVELOPMENT for the year to September 30 last show a group profit of £1,594,840 and a total of £1,810,390 available, of which dividends equal to 124% require £1,083,500. In the year 932,130 tons of ore was treated and 30,762 tons of concentrates produced. The smelter production from 36,867 tons of concentrates was 13,740 tons of copper. The Messina ore reserves at September 30, 1960, were estimated as 6,374,570 long tons assaying 1·61% copper, while at Umkondo the proved and probable ore reserves were 137,370 long tons averaging 3·89% copper after including 3·38% from oxides. In addition, possible ore reserves were 134,940 long tons averaging 2·76% copper after including 0·99% oxides. In October last the company's tender for the purchase of certain assets of NORTHERN TRANSVAAL (MESSINA) COPPER EXPLORATION was accepted by the Liquidator. These assets include 3,195 claims and a mining lease covering 66 morgen 399 sq. roods, situated from six to ten miles to the west-south-west of Messina.

The report of the CONSOLIDATED MINES SELECTION COMPANY for 1960 shows a profit of £319,623 and a total of £366,274 available. Of this amount £126,527 has been placed to reserve, while £183,345 is required for dividends equal to 2s. 6d. a share, leaving £55,902 to be carried forward.

NIGEL FINANCE AND INVESTMENT reports a profit of £29,966 for the year ended September 30 last, making with the sum brought in an available total of £47,138, of which a dividend equal to 6d. a share requires £18,375.

Orange Free State.—The operations of LORAINE GOLD MINES in the year to September 30 last resulted in a surplus of £235,888; a credit balance of £283,197 is carried forward. At the mine 947,500 tons of ore was milled and 198,582 oz. of gold was produced, while the company's apportionment of uranium oxide is given as 181,592 lb. At the end of the year the available ore reserves were estimated to be 1,106,000 tons averaging 6·87 dwt. in gold and 0·32 lb. of uranium oxide per ton over a width of 45·6 in.

Southern Rhodesia.—M.T.D. (MANGULA) reports a profit of £923,485 on its operations in the year ended September 30 last. With the sum brought in there was £926,232 available, of which dividends equal to 9d. a stock unit require £750,000. The output for the year was 25,923 short tons of concentrates with an average copper content of 49·75%, of which 24,120 short tons were shipped to refineries overseas and the balance stockpiled for treatment at the Alaska smelter. The ore reserves at September 30, 1960, were 25,421,880 short tons assaying 1·31% copper, as compared with 25,335,000 short tons assaying 1·36% at the end of the previous financial year.

The accounts of FALCON MINES, LTD., for the year to September 30 last show a profit of £154,776 and £164,222 available, of which £95,319 is required for dividends equal to 20%. At the Dalny mine 246,400 tons of ore was milled and 47,431 oz. of gold recovered, while 1,177 oz. came from Sunace and 1,340 oz. from Bay Horse. The estimated ore reserves in the Dalny and Pixy sections at the end of the financial year were 681,000 tons averaging 5·04 dwt. over 111 in. In his review accompanying the report and accounts the chairman says that the development of the Dalny section has now reached the stage where permanent arrangements are needed for handling ore below 13 level and for continued exploration at depth. Accordingly a recommendation of the consulting engineers that a sub-vertical shaft collared on 13 level

be sunk to a depth of 1,100 ft. at an estimated cost of £110,000 has been accepted. This expenditure, to be met from revenue, is to be spread about equally over the next two financial years.

With the recent dividend notice shareholders of the NORTH CHARTERLAND EXPLORATION CO. (1937) are informed that the profit for 1960 is £24,412. A dividend equal to 16⅔% requires £7,989, while £17,000 has been transferred to reserve, leaving £3,795 to be carried forward.

Ghana.—The operations of the ASHANTI GOLDFIELDS CORPORATION for the year ended September 30 last resulted in a profit of £1,100,732, the accounts showing £1,649,504 available. Of this amount £828,470 is required for dividends equal to 2s. 2d. a share, while £300,000 has been placed to reserve. After other allowances a balance of £507,927 is carried forward. In the year the mill treated 436,781 tons of ore, the average grade being 17·74 dwt. In all 357,335 fine oz. of gold were recovered, the rate of extraction being 92·27%. The ore reserves at September 30, 1960, were 2,558,287 tons, with a grade of 16·89 dwt. The tonnage was 565,182 tons higher than in 1959 but the grade was lower by 0·35 dwt.

The report of BIBIANI (1927) for the year to September 30 last shows a loss of £70,250. From the credit balance still available dividends equal to 4·8d. per share required £30,625. In the year the mill treated 381,076 tons of ore to recover 81,297 fine oz. of gold, 23,451 tons and 4,778 oz. less than the previous year. The ore reserves at September 30, 1960, were 324,528 tons at an average grade of 6·14 dwt. This was a fall of 466,538 tons with a rise in grade of 0·9 dwt. The report states that the results of development over the past four years have not added sufficient new ore to the reserves to replace tonnage mined. An approach was made to the Ghana Government for assistance to meet increased working costs and to finance further development, but the company was informed that it was the policy of the Government not to give help to mining companies. In the event, as was noted in the February issue, the Government is to acquire all the shares of the company.

KONONGO GOLD MINES reports a profit of £107,070 for the year to September 30 last, an available balance of £208,589 being available, of which dividends equal to 3d. a share require £53,626. During the year 84,766 tons of ore was treated to yield 44,639 oz. of gold. At the end of the financial year the ore reserves were estimated to be 178,170 tons averaging 14 dwt. in value over 63 in.

Nigeria.—In the MAGAZINE for September last mention was made of the intention of CONSOLIDATED TIN SMELTERS to go ahead with the erection of a tin smelter on the Jos Plateau. Earlier this month notice was given of the formation of a company, MAKERI SMELTING, to operate the new plant, which is to be opened some time in the current year.

Australia.—At an extraordinary meeting of the LAKE GEORGE MINING CORPORATION to be held on March 14 after the annual meeting it is to be proposed that the capital be reduced to £888,000 by the return of 2s. on each 5s. share. Thereafter 888,000 new 5s. shares are to be created. In the year to June 30 last the Corporation accounts showed a surplus of £92,991 carried forward. In the year the operating company, LAKE GEORGE MINES PTY., treated 197,354 tons of mined ore and recovered 15,401 tons of lead concentrates, 29,711 tons of zinc concentrates, 4,232 tons of copper concentrates, and 34,800 tons of pyrite. The report states that the prospecting and exploration programme was almost concluded at the end of the year, having "failed to disclose any economic extensions of the existing ore-bodies or to reveal any new deposits."

It was announced in Melbourne last month that agreement had been reached with METAL MANUFACTURES, LTD., for the purchase by COMALCO ALUMINIUM PRODUCTS of the aluminium fabricating facilities of AUSTRAL BRONZE CO. PTY., LTD., in New South Wales and Victoria. The latter is a wholly-owned subsidiary of Metal Manufactures and Comalco Aluminium Products is the fabricating subsidiary of the CONSOLIDATED ZINC-KAISER ALUMINUM partnership, recently incorporated in Victoria with a nominal capital of £A10,000,000. As a result of these negotiations Comalco Aluminium Products will take over the Cumberland brass and aluminium mills of Austral Bronze at Yennora near Sydney.

In the period September 28 to December 20, 1960, development at LAKE VIEW AND STAR totalled 6,878 ft., of which 4,664 ft. was driven to develop the various lode channels. 2,765 ft. or 59·3% being in ore averaging 6·6 dwt. per ton over a width of 56 in. In the Lake View and Associated Mines, or Eastern Group, of 1,688 ft. driven on various lode channels, 1,137 ft., or 67·4%, averaged 6·8 dwt. per ton over a width of 55 in. In

the Western group of mines driving on the various lode channels totalled 2,976 ft., of which 1,628 ft., or 54·7%, averaged 6·4 dwt. per ton over 57 in.

Malaya.—At the annual meeting of RAUB AUSTRALIAN GOLD MINING held in December last the chairman stated that immediate mining prospects appear better, ore being now available from Nos. 9 and 10 levels, Derrick shaft, where sinking has been completed and driving has intersected the downward continuation of the ore-body. Exploration on the No. 10 level has disclosed, he said, that on the north side of the fault the ore-body has been picked up and continues in the same form on the incline to the east as it did on the south side of the fault. Similar occurrences south of the fault at Malacca shaft lead to the possibility of a valuable ore-body existing between these two shafts in ground hitherto untouched.

At a meeting of KUALA KAMPAR TIN FIELDS to be held in Kuala Lumpur on March 14 it is to be proposed that the £307,500 standing to the credit of the " Assets Revaluation Reserve " should be capitalized and the sum of £307,500 be made available for distribution.

The operations of PETALING TIN in the year to October 31 last resulted in a profit of £111,918, making with the sum brought in an available total of £271,354, of which dividends equal to 35% require £107,800. In the year 5,194,300 cu. yd. of ground was treated and 1,174 tons of tin ore recovered.

Shareholders of AMPAT TIN DREDGING have been informed that the Bidor dredge has been shut down for major repairs but is expected to resume operations towards the end of April.

Burma.—The operations of the BURMA CORPORATION (1951), the operating company jointly owned by BURMA MINES and the Burma Government, suffered a loss of £85,080 in the last quarter of 1960, principally due to lower metal prices. However, in addition, it is pointed out that a deterioration in the foundations of the No. 1 winder will necessitate the dismantling of this unit, which hoists all ore from below No. 6 level. The winder is expected to be out of action for about six months and consequently " there will be a serious curtailment in extraction and marketable products." Shareholders are to be informed as soon as possible as to the likely extent of the reduction in operations.

Mexico.—SAN FRANCISCO MINES OF MEXICO reports a profit of £407,125 for the year ended September 30 last, the accounts showing £787,059 available for appropriation. After transferring £150,000 to reserve a dividend equal to 1s. 6d. per unit of stock requires £188,970 and after other allowances a balance of £443,089 is carried forward. In the year the 819,000 metric tons of ore milled yielded 52,924 tons of lead concentrates, 94,031 tons of zinc concentrates, and 9,718 tons of copper concentrates. Ore reserves are given as 5,941,780 tons, of which 3,843,120 tons are fully blocked out. The report states that development work at Frisco and Clarines totalled 9,198 metres. A pilot plant for the recovery of acid-grade fluorspar concentrates from mill tailings was successfully operated during the year and it has been decided to proceed with the erection of a plant to treat current mill tailings. Construction of a plant capable of producing about 60,000 metric tons per annum of fluorspar concentrates is expected to be completed during 1961. The cost, some £300,000, is to be met from the company's resources.

Canada.—The report of the INTERNATIONAL NICKEL CO. OF CANADA and its subsidiaries for 1960 shows net earnings of $80,701,000 in terms of U.S. currency, which compares with $85,157,000 for 1959. The company delivered 351,880,000 lb. of nickel in 1960, an all-time record and an amount greater than its production capacity in that year. These record deliveries included 51,410,000 lb. of nickel which made no contribution to earnings, having been acquired from the United States Government or its suppliers and sold to the trade at the same prices at which it was acquired. Factors affecting earnings adversely in 1960 were, it is stated, reduced deliveries of nickel produced from the company's own mines and plants, higher costs for labour and services, and increased provisions for depreciation and income tax. Favourable factors affecting earnings were increased sales of rolling mill products, improved prices for the platinum metals, and increased deliveries of copper. Exploration expenditures amounted to $8,873,000 in 1960, as compared with $7,989,000 in 1959, with slightly less than half of the total expenditures in Manitoba and approximately one-third in the Sudbury district. Exploration programmes or the examination of ore occurrences were also carried out in northern Ontario, Quebec, Saskatchewan, and the Northwest Territories of Canada, and in Africa, Australia, Greece, Guatemala, the South Pacific Islands, and the United States.

In June last production at RIX-ATHABASCA URANIUM MINES came to an end, depletion of the known ore reserves coinciding with a change in marketing contract regulations which resulted in the closing of the Lorado custom mill. The short-term contract with the Eldorado milling plant at Beaverlodge also terminated at about this time. Production to the end of June amounted to 15,600 tons of ore, which was shipped for a gross value of $381,000. Operations in 1960 resulted in a loss of $74,877, but recovery of the 1958 deposit into the Lorado security fund resulted in a net profit of $73,076. No further surface exploration work was carried out on the Beaverlodge property and only a limited amount of development work done in the Leonard mine.

Sweden.—It was reported last month that a large iron-ore mining field is to be opened up in the Svappavaara district in Arctic Sweden situated along the road between the present Kiruna and Malmberget fields. The deposits in the new mines are estimated at well over 300,000,000 tons, partly of high-grade ore. According to preliminary plans activities will be concentrated on the Leveäniemi deposit and will be carried out as open-cut mining. At the same time the Swedish State Railways plan to build a 40-km. railway from Svappavaara to Kiruna at a cost of Kr.40,000,000. The line will be electrified and designed for automatic operation. It will permit of an axle load of 25 tons.

Production at LKAB's Kiruna and Malmberget mines reached a new peak of 15,700,000 tons in 1960. Planned expansions are estimated to increase Kiruna's output to 15,000,000 tons and Malmberget's to 6,000,000 tons by 1965. With the addition of Svappavaara the company's output would reach about 24,000,000 tons in the latter half of this decade. Since the capacity of the present "Iron Ore Railway" in this district and existing facilities in the shipping port of Narvik suffice only for handling the output from Kiruna, the Svappavaara ore will be shipped over to the Swedish port of Lulea at the northernmost end of the Gulf of Bothnia.

United Kingdom.—At an extraordinary meeting of HALKYN DISTRICT UNITED MINES to be held later this month it is to be proposed that the capital be reduced to £208,864 17s. by repaying ordinary stockholders 1s. on each 2s. stock unit held. Thereafter the capital is to be increased to £250,000 by the creation of 822,703 ordinary 1s. shares and the existing 2s. ordinary shares are to be divided into 1s. units.

British South Africa Company.—The accounts of the British South Africa Company and its subsidiary companies for the year to September 30 last show a profit of £8,148,245. Dividends equal to 7s. 6d. per unit or share require £4,128,863. In his statement the president notes that the principal prospecting companies continued searching for new mineral reserves on the same scale as last year, over £1,000,000 being spent altogether in Northern Rhodesia. No new discoveries were made which deserve special mention, it is considered.

DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated.)

†**Consolidated Mines Selection Co.**—1s. 6d., payable Mar. 28.

Consolidated Tin Smelters.—Pref. 3½%, payable May 12.

***Coronation Syndicate.**—2½ cents (3d.), payable Apr. 4.

†**Konongo Gold Mines.**—2d., payable Mar. 30.

***London Tin Corporation.**—1s. 1·2d., payable Mar. 30.

***Lydenburg Gold Farms.**—1½ cents (1·8d.), payable Apr. 7.

***Mount Morgan.**—9d. (Aust.), payable Mar. 30.

***New Witwatersrand Gold Exploration Co.**—3 cents (3·6d.), payable Apr. 7.

†**Nigel Finance and Investment.**—6d.

†**North Charterland Exploration Co. (1937).**—2d., payable June 16.

†**Rhodesia Broken Hill Development.**—9·6d.

***Rhodesian Anglo American.**—3s. 2·4d., payable May 4.

***Rhokana Corporation.**—2s 4·8d., payable May 4.

***Transvaal and Delagoa Bay Investment.**—8½%, payable Mar. 22.

†**Witbank Colliery.**—1s. 3·6d., payable Mar. 17.

†**Witwatersrand Gold Mining Co.**—4 cents (4·8d.), payable Apr. 20.

METAL PRICES

Mar. 8.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	210	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	30	5	0
Silver		6	7⅝
Gold	12	11	3½
Wolfram (U.K.)		—	
(World)	6	7	6

Tin, Copper, Lead, Zinc — See Table, p. 176.

Mineral Activities in Turkey

W. Domzalski, A.R.S.M., Ph.D., D.I.C.

A review of the present status of and prospects for the mining industry

Introduction

The author has spent several months on separate occasions in Turkey as consultant to the Turkish Government Mineral Exploration Institute in connexion with a large mineral exploration programme involving airborne and ground geophysics and general follow-up work. During these several visits, apart from the purely technical problems connected directly with the survey, he has had to acquaint himself with the broader aspects of the mining exploration, exploitation, and ancillary activities of the Turkish mining industry.

In the pursuit of this background knowledge a number of larger mineral deposits were visited and informative field trips undertaken. Various organizations connected directly or indirectly with the mining industry contributed information on the economic background of the main technical task facing the author.

The commencement of the first visit coincided with the Revolution in Turkey which took place on May 27, 1960. This event, which in itself is of enormous national significance, is mentioned here in order to demonstrate how important the development of the mining industry is considered there. In spite of the almost complete and rapid re-orientation of many aspects of industrial, commercial, and financial pattern of the country, the mineral exploration programme was delayed only for about a fortnight which, under the political and general conditions prevailing at that time, must be considered the most remarkable achievement, reflecting the importance of the undertaking and its possible implications.

The economic position of Turkey has been and still is difficult. Many basic manufacturing industries need not only to be expanded but, in many instances, created. The foreign exchange position is precarious, exports insufficient, and imports, although limited to a bare minimum, nevertheless a great burden and a drain on the national budget.

These statements must not be taken as criticisms. On the contrary, they may serve to stress the fact that in spite of these difficulties the nation forges ahead along a very broad front and, even if immediate results may appear slow, the progress is being achieved on many sectors of the national economy simultaneously. For example, the Foreign Capital Investment Encouragement Law is a proof that even for the price of sacrificing precious foreign exchange, and consequently perhaps causing temporarily additional discomfort, the country is determined on a policy of industrialization and eventual expansion.

Turkey, with a population of close to 28,000,000, has an area of about 300,000 sq. miles, of which just over 9,000 sq. miles are west of the Bosphorus and Dardanelles and known as Eastern Thrace. The remainder, known as Anatolia, is in Asia Minor. The extent from west to east is about 900 miles from the Aegean Sea to the Iranian border and somewhat more than 300 miles from the Black Sea in the north to the Mediterranean and Syrian border in the south.

The country is divided into a number of well-defined physiographical features, the most important of which are the Central Anatolian Plateau, the Pontides Mountains in the north, and the Taurus in the south. The variety of climates ranges from mild and humid in the west to dry and predominantly continental in the centre and to the very extremes in the east, where summer temperatures reach 90° F. and during the winter months fall to 40° F. below zero.

This is matched by a variety of topographical features with mountains attaining elevations of close to 17,000 ft. (Mt. Ararat) and low coastal areas, not to mention the variety of scenery and antiquities.

Turkey is still predominantly an agricultural country, with main products of figs, grapes, nuts, tobacco, cotton, olives, and some wheat and barley. These are also the major exports, while the main imports consist of steel, machinery, raw hides, paper, fertilizers, as well as a number of chemical and consumer goods.

No mention is made here of mineral resources because this is the main subject of the section which follows.

Mineral Resources of Turkey

The enormity of the task of describing the mineral occurrences in Turkey can be realized by quoting that the known occurrences of chromite ores alone number over 500. Consequently in any attempt at a reasonably comprehensive but, at the same time, compact presentation of this subject, detail has to be sacrificed for the sake of presenting a general aspect and trends. At the same time it is necessary to remember that those tens and sometimes hundreds of occurrences of various minerals are usually of small tonnage, or at least of small proved tonnage, with a few exceptions. This fact is largely responsible for the pattern of the mining industry which is characterized by its fractionality of the individual effort and the lack of sustained continuity.

There are occurrences of a great many different minerals in Turkey of varying importance regarding their size, frequency, and possibility of production. Thus classification regarding their relative importance *at present* has to be based on the available production figures and, in the case of minerals not mined at present, on the frequency of their occurrences.

Metallic Minerals

The metallic minerals are considered first. What are termed the most important minerals will be listed first together with their production figures. The minerals of which the production is negligible at present are listed later in sequence of the frequency of their recorded occurrences. The production figures given in Table 1 are in metric tons and the figures in brackets denote the year for which the latest data are available.

Other occurring metallic minerals whose production is negligible or non-existent include those shown in Table 2.

In all the total national reserves on the basis of the present published knowledge are estimated at over 6,000,000 m. tons of chrome ore, of which over 60% are of the metallurgical grade. The estimates of reserves are very approximate and, even apart from the potential new discoveries, the reserves are probably bigger than the figures given.

Table 1

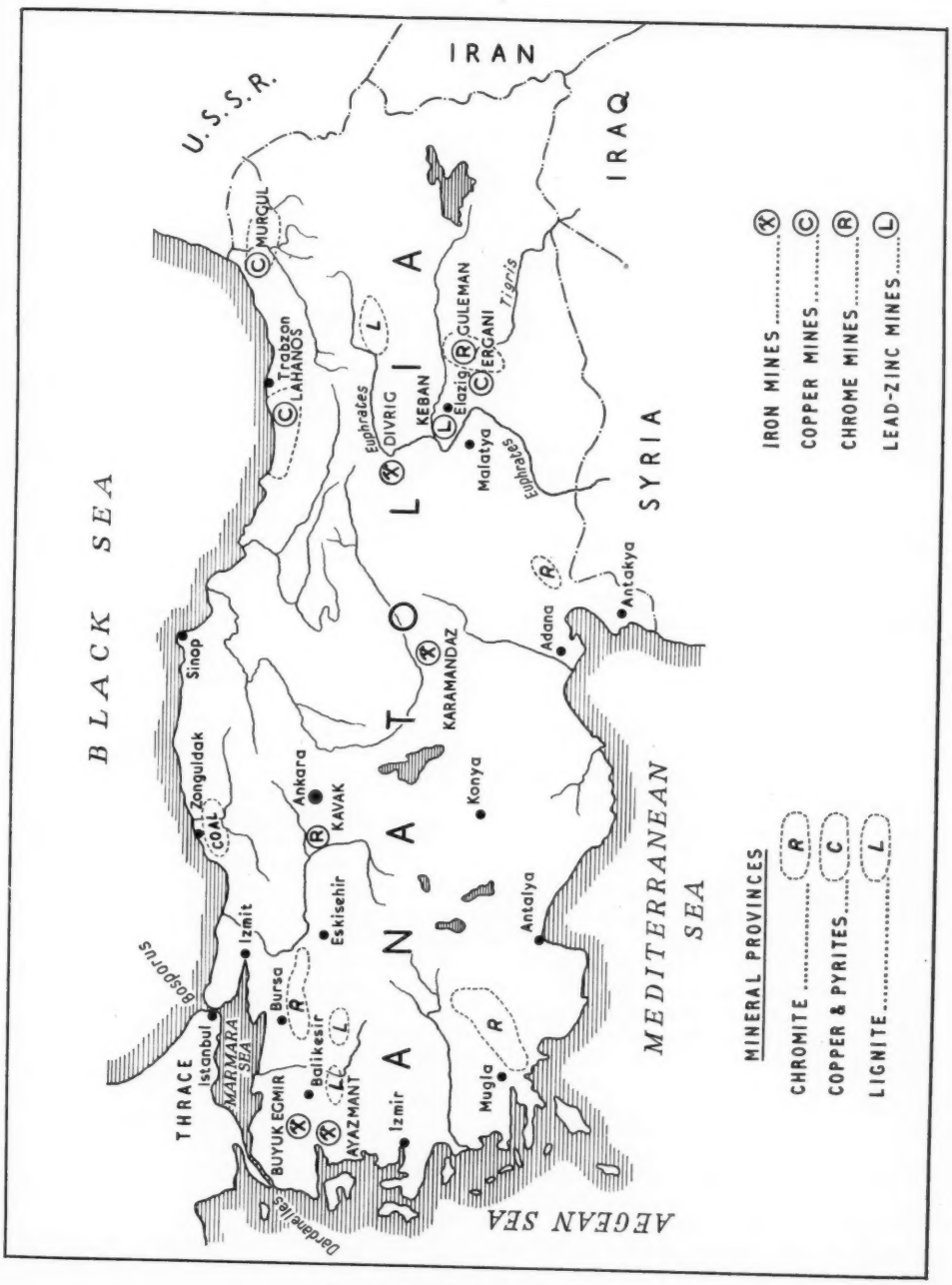
Mineral	*Ores predominant*	*Ore production*
Iron	Magnetite Hematite	930,500 (1956) 1,200,000 (1957)
Copper	Chalcopyrite Copper Pyrites	90,000 (1959)
Chrome	Chromite	833,000 (1956)
Manganese	Pyrolusite Psilomelane	61,000 (1956)
Lead-Zinc	Galena Sphalerite	15,000 (1959)
Silver		pure 8,000 (1959)
Mercury	553 bottles (at 76 lb. in 1959)	

Regarding locations where the mineralization occurs it is extremely difficult to describe them shortly because they are spread throughout the country. In general, and this is a very broad generalization, the western and northeastern parts of Turkey are richest in mineral occurrences. It is safe to say, however, that in each province there occur some signs of mineralization. A better idea may be perhaps obtained from the following discussion of the most important minerals.

Iron.—There are at least 72 iron deposits and confirmed occurrences of varying size. Of these about 20 are being commercially exploited. It is necessary to stress, however, that, except for a few large deposits, others are worked intermittently, depending on the market demand.

Table 2

Mineral	*No. of reported occurrences*	*Remarks*
Magnesite	54	Occurrences from a few hundred to 150,000 m.t. Average contents 40% Mg. Small production of 1,000 m.t. in 1956.
Antimony	17	
Arsenic	12	
Molybdenum	5	One reportedly large.
Tungsten	4	Most important deposits are in the area of Bursa and Balikesir. Proved reserves are estimated at 7,000,000 m. tons of ore averaging 0·4% tungsten. This would put Turkey as the fourth country in the world, as regards reserves.
Nickel	4	Minor importance.



Sketch Plan of Mineral Areas

Table

Mine	*Location*	*Mineral*	*Reserves*	*Production*
			m. tons	m. tons
Divrig	Between Sivas and Elazig in eastern Anatolia.	Magnetite Hematite	27,000,000	510,000 (1957)
Büyük Egmir	Between Edremit and Balikesir in north-western Anatolia.	Hematite Limonite	14,000,000	340,000 (1957)
Ayazmant	North of Bergama, north-western Anatolia.	Magnetite	10,000,000	59,000 (1957)
Karamadaz	Near Kayseri, central Anatolia.	Magnetite	2,500,000	60,000 (1956)
Yakyali	Near Kayseri, central Anatolia.	Magnetite	2,000,000	53,000 (1957)
Kangal	Near Sivas, eastern Anatolia	Magnetite Hematite	1,500,000	31,000 (1957)
Kesikköprü	South-east of Ankara, central Anatolia	Magnetite	< 1,000,000	35,000 (1959)

Table 3 summarizes the more important information about producing or capable to produce mines of the greatest tonnage of production. In addition to the mines listed another 13 smaller mines are operated privately with production ranging down to 5,000 m.t. per year.

Although not in production two deposits deserve special mention. One in Eastern Anatolia, near Hekimhan, north-west of Malatya, is still under investigation. The reserves are estimated over 20,000,000 m. tons of magnetite, hematite, and siderite. Another is a huge deposit of low-grade hematite ore estimated at 18% to 40% Fe. It is the Camdag deposit, north-east of Izmit, estimated at 80,000,000 m. tons.

Copper.—There are some 50 to 70 copper deposits and occurrences spread across the whole country. The most important, however, are concentrated in Eastern Anatolia.

The largest producing mine is the State-owned Ergani Bakir Madeni (Etibank), situated south-east of Elazig. The reserves are estimated close to 20,000,000 m. tons, of which 4,000,000 m. tons are of rich ore at up to 12% Cu and the remaining 16,000,000 m. tons average at 2½% Cu. The production is at present 730 m. tons per day of ore, or 55 tons per day of 99·6% pure copper. The upper part of the ore-body, consisting of cupriferous pyrites, grades in depth into chalcopyrite. The ore-body occurs in diabase near the contact with serpentine. Some chlorite schists are present in the vicinity. The mine is worked as an opencast, the top level being about 60 m. below the original level of the surface.

Another important exploited deposit occurs east of Murgul in the extreme north-east of Anatolia, close to the Soviet border. This mine is operated also by Etibank, with reserves estimated at 15,000,000 tons and average contents of 2% Cu.

An important deposit at Lahanos, east of Giresun and at the Black Sea coast, is now under investigation. Smaller deposits but of possible commercial value occur in north-western Anatolia.

Chrome.—Chrome is perhaps the most important mineral occurring in Turkey. The production varied over the years since the middle of the 19th Century, depending on the market demands. Towards the end of last

3

Type	*Fe Content,* %	*Owned*	*Remarks*
Opencast Contact of syenite and ferruginous limestone.	50–68	(State) Etibank (Divrigi Demir Isleti).	The ore is transported by rail to State-owned Karabük steel plant near Longuldak, some 900 km. away. The cost of transport is 5½ times that of ore at the mine railhead.
Opencast. In kaolinized volcanics.	57–60	(Private) Dümek Ticaret T.A.O. (Istanbul).	Ore exported to Germany. Discovered in 1951.
Vein deposit in granodiorite, three parallel veins 1·5 km. long. Opencast.	60	(Private). Altinova, Ltd., Sirketi.	Ore exported. Mine interrupted production in 1960.
Opencast. Contact of limestone and granite syenite intrusion.	60	(Private) Mustafa Koyanen.	Ore sold to Karabük steel plant.
Opencast Contact of limestone and granite intrusion.	58	(Private) Ozkoynan, Ltd., Sirketi.	
Opencast.	55–60	(Private) Tetiko Tek-vetic, Ltd., Sirketi.	
Opencast. On contact of limestone and altered granite.	60	(Private) Kesikköprü Demir Madeni, Ltd., Sirketi.	Total production since 1953: 92,000 m.t.

century Turkey was the biggest producer. In more recent years chrome has been on occasions Turkey's most important export.

There are over 500 known occurrences of chrome ore, of which approximately one-third have been exploited at some time or another within the last ten years. During the same period of time the number of operators was over 50, with the biggest mines being worked by the State.

Chrome occurrences are widely distributed throughout the country, although the most important deposits are concentrated in a few areas only. Thus in south-western Anatolia, south and east of Mugla, a great many deposits occur in the belt of ultrabasic rocks (altered peridotites, gabbros) extending approximately N.E. to S.W. This is probably the second most important district in Turkey regarding the chrome-ore reserves, estimated at present at some 1,500,000 m. tons.

Another important chrome province is situated south of the Sea of Marmara, between Bursa, Balikesir, and Eskisehir where, again, numerous deposits of limited size may add up to total reserves of about 750,000 m. tons.

Of somewhat lesser importance as regards possible reserves, but still deserving a separate mention, is the district west of Gaziantep, which is north-east of the Bay of Iskenderun (Alexandretta).

The most important chrome mining activities take place in the Elazig district. There the State-operated Guleman mine averaged over the last ten years about 150,000 m. tons per annum. Reserves of this district could be estimated at about 2,000,000 m. tons.

Manganese.—There are some 120 known occurrences of manganese, some of them within economical range for a small operator. About 75% of occurrences are in western Anatolia.

Regarding productive deposits some 15 private operators were active in as many deposits.

Lead-Zinc.—Lead and zinc occurrences are found rarely on their own, usually being associated with each other and sometimes with copper, cobalt, cadmium, silver, and gold.

There are some 70 known occurrences and small deposits in all parts of the country. The only producing mine of some size, Keban on the Euphrates, near Elazig, is State-

operated. Some disseminated pyrites is present together with lead and zinc which occurs on the contact of syenite porphyry and marble. Calcareous and graphitic schists are in the vicinity. Reserves are not very large and the production averages 60 m. tons per day. Lead concentrate is treated in Germany and zinc in England. Transport is by lorry to Elazig, thence by rail to the port of Iskenderun (Alexandretta).

Another small private mine is at Karakoca, north of Simav in western Anatolia.

Non-Metallic Minerals

Only a short résumé of the occurrences of the non-metallic minerals can be given here.

It will be appropriate to begin this account with lignite, which is by far the most widespread of all economical deposits of Turkey. The known occurrences number over a thousand and are found practically in all provinces of the country. The most important deposits, however, are in western Anatolia, in the Kutahya and Manisa provinces, and in Thrace. Some large deposits are also encountered in extreme eastern Anatolia in the Erzurum province. The estimated reserves of lignite amount to 250,000,000 m. tons and the production in 1956 was over 3,000,000 m. tons.

Practically all known reserves of bituminous coal in Turkey are concentrated around Zonguldak on the Black Sea coast. There the State operates the Eregli mines. Reserves are estimated at 1,000,000,000 m. tons. Production in 1956 was close to 6,000,000 m. tons and the immediate target is to reach 10,000,000 m. tons annually.

The information about other minerals in this group is summarized in Table 4.

It is of interest to stress the possibilities of development of borax mining on a larger scale than hitherto. This is a fairly important mineral, particularly for strategic reasons, and the development of known deposits may prove a venture of interest. In addition there are reported occurrences of barite, graphite, fluorite (mined), talc, mica, asbestos, meerschaum (mined), and alum.

It must be borne in mind that the figures given regarding the estimated reserves are only approximate and rarely based on the full evaluation of the deposit unless it is an operating mine of some standing. In certain cases evaluation is in progress, particularly in the case of large deposits in which the State is interested. On the other hand some deposits are very incompletely known.

Organization of Mineral Activity

Of the two possible partners in any industry, State and private enterprise, the State is more active and better organized in the field of mineral activity in Turkey. Whatever the reasons may be, whether it is the lack of capital, lack of incentive, preference of commercial to industrial activities on the part of private enterprise, the pursuit of quick turnover and profit, together with reluctance of long-term investment in the mine development, or preponderance of State in these matters, the fact remains that the present-day mining activities in Turkey are characterized by a majority participation of the State.

It will be appropriate therefore to commence with a brief discussion of the mineral activities conducted by the State. These, together with a number of other industrial

Table 4

Mineral	*Occurring*	*General Location*	*Total estimated Reserves* m. tons	*Remarks*
Bauxite	11	North-Western Anatolia, east of Iskenderun Bay	15,000,000	No production.
Native sulphur	7	Western Anatolia mainly.	1,000,000	State-operated mine near Isparta. Production 10,000 m.t./year. Also recovered in two copper mines.
Borax	4	Western Anatolia.	Several million.	Large deposits near Emet belong to Etibank. Private group Mortas produced over 100,000 m.t. in 1959.
Emery	50	Western Anatolia.		About ten deposits were worked by private operators for export. Most of known deposits are considered workable.

undertakings, fall under the jurisdiction of the Ministry of State Enterprises (equivalent to industries). The three phases of mineral activities which can be commonly recognized—*i.e.*, exploration, assessment, and exploitation—are handled by two Government organizations, the Mining Research and Exploration Institute and Etibank.

The Mining Research and Exploration Institute in Ankara (Maden Tetkik ve Arama Enstitusu) fulfils a role similar to that of a Geological Survey with perhaps a larger scope and more diverse fields of action. Its main tasks are: (1) Geological mapping; (2) prospecting and exploration for the sake of the economical development of the country; (3) assessment, proving, and estimation of reserves of located deposits by further geological investigations, drilling, and limited excavation; (4) studies and analyses in the field of geology and allied sciences on behalf of other Government Departments and at cost for private individuals or groups; (5) publication of certain findings beneficial to the public interest, and (6) collection and classification of reports and documents on ore occurrences, mines, etc., together with facilities to render these accessible to private investors.

To carry out these varied and important assignments the Institute operates through various internal departments whose work is co-ordinated under the overall guidance of the General Director. The Institute, apart from the Departments through which its main tasks are discharged, such as geology, mining geology, geophysics, atomic minerals, surveying, drilling, chemistry, etc., has its own fleet of transport, printing establishment, and a host of auxiliary services.

The airborne magnetometer survey now in progress over areas totalling some 54,000 sq. miles is carried out under the auspices of the Institute. Its teams of geophysicists and geologists will be engaged on the ground follow-up work. It is interesting to note that this is possibly the largest single survey of this kind ever undertaken.

The Institute does not carry out the exploitation of the mines. The Government-owned mines are managed, exploited, and products marketed by Etibank. Etibank is concerned with the executive and commercial phase of the mining, as well as with power production. Consequently one branch is devoted to the problems of power generation, production, and distribution, while another deals with running of State mines. It may be of interest to recapitulate here that among others Etibank is responsible for by far the largest proportion in production of: Coal (Eregli, Zonguldak); iron (Divrig); copper (Ergani, Murgul); chrome (Guleman); lead-zinc (Keban), and sulphur (Isparta). Although the State mines represent the biggest single production units in each type of mineral, nevertheless the cumulative production of private mining companies is in many instances greater than the State production.

The striking feature of the private mining industry in Turkey is the great number of small "companies." In many instances it may be almost a one-man outfit. A small deposit of manganese amounting to 50,000 tons, as actually seen by the writer, may be worked intermittently, producing 6,000 tons or so in a year. It will be operated by about 15 to 20 men and a foreman and will be in a great majority of cases an opencast. Although the main quarrying is done with the help of dynamite, the actual breaking of ore and sorting is manual.

This "fractionality" of the industry may be best illustrated by quoting the fact that there are 106 registered chrome mining companies, yet almost 70% of production comes from about 10 larger companies, while the remaining 96 produce about 30% of the total production. In the case of iron there are over 20 private firms engaged in a varying scale on mining this mineral. The larger numbers, in the case of chrome, are explained by the fact that it is a more profitable mineral and that there are a great many occurrences.

The number of foreign firms, or rather Turkish firms with visible foreign capital, is not large. The mining law (see the following paragraphs) is not as liberal as the oil law and does not provide particularly great incentives at present.

Foreign-backed companies include: One French (chrome in the districts of Mugla and Fetihye), one Swedish (the same as the French), one German (chrome in the district of Fetihye, Denizli), and two British (chrome, mercury, and borax).

Mining Law

The Mining Law now in force was adopted in 1954. Its fundamental concept is that the minerals are owned by the State and are not therefore a part of the land where they are found. Thus the right to explore and exploit is granted by the State to those who apply and satisfy certain conditions.

There are distinct types of permits, appropriate to different stages of operations. It will be noted that for prospecting no permit of any kind is necessary. The phases for which permits are required include :—

Exploration

The exploration permit covers an area not in excess of 2,000 hectares (4,940 acres) and allows all survey and exploration activities, including drilling, trenching, driving exploratory galleries, and producing samples not in excess of 2,000 metric tons from one exploration permit area.

This type of permit is valid for two years, cannot be extended, but is transferable and can be given only to a Turkish citizen, Turkish State enterprise, or a company formed under Turkish laws for mining and exploration purposes.

Each exploration permit is given for one type of mineral only, but the complex ore case is covered by a simple extension. The exploration activities must be carried out under the supervision of a qualified mining engineer, geologist, or other technician.

Operation

If a deposit is located and the necessary data like its boundaries, estimated quantity, and quality approximately determined, the explorer becomes legally " a discoverer," the deposit is termed " discovered mineral deposit," and the Ministry of Economy and Commerce issues the operating permit. Such a permit is issued only to a Turkish citizen, Turkish State enterprise, or to a company formed under Turkish laws. The operating permit is valid for up to 15 years.

Concession

Depending upon the ore reserves, quality, and the general importance of the deposit, the operating permit may be changed to a concession. A concession is valid for up to 99 years and it can be granted only to a Turkish State enterprise or a Turkish company. Operations under the operating permit or concession must start within one year of the date of issue and must be conducted under the supervision of a mining engineer. Monthly and annual reports and maps must be presented to the Ministry.

The royalty on ore sold varies from 1% to 5%. It is recommended by the Ministry and fixed for each operating permit or concession at the time of granting. Royalty is paid as follows : In the case of exports on f.o.b. sale price of ore at the port of embarkation ; in the case of domestic sales, on average sale prices obtained by comparable mining operations. Payment of royalty is on quantity of ore undertaken to be sold in a given calendar year. The overpayment in case of underselling can be equalized over the next three years. In addition all normal taxes applicable to a given undertaking are also payable.

The Turkish Mining Law is published in English jointly by the Legal Research Institute of the Faculty of Law of the University of Ankara and the Graduate School of Public Administration and Social Service of New York University.

Foreign Investment Encouragement Law

This law was introduced in 1954. Its aim is to encourage the import of foreign capital to Turkey so that various industries can be created or expanded. Under the law the capital investments and profits can be transferred from Turkey abroad in the currency of the country where the capital originated. The employment of foreign specialists and skilled personnel by the enterprise who operates under the law is permitted.

An enterprise is granted the facilities under this law if its activities tend to promote the economic development of the country, if they do not involve monopolies, and if they are in the field open normally to Turkish private enterprise.

The applications for operation in Turkey under the Foreign Investment Encouragement Law are made to the Ministry of Economy and Commerce, where they are dealt with by a special committee. The appeal from the decision of this committee can be made within 30 days of its decision to the Appeal Authority composed of the Ministers of Finance, Commerce, and State Enterprises.

Conclusion

At present Turkey's mining industry has not yet reached the stage which may be expected from the country's great mineral potential. The reserves in the known deposits may be greater than estimated at present and there are serious possibilities of new discoveries.

There is need for capital of two kinds : An adventurous capital, prepared to bear exploration risks for large possible rewards, and a more separate type of capital to check on some of the existing deposits, develop them, and produce on a reasonable and profitable scale.

Tunnel in the Highlands

Note is taken of a practical demonstration of Swedish ladder drilling

Through the courtesy of the Atlas Copco organization and George Wimpey and Co., Ltd., we were recently enabled to visit a tunnel project in the Cruachan Section of the Awe scheme of the Scotland Hydro-Electric Board. Particular interest attached to the visit since Wimpey's are using the ladder-drilling method, described in the December issue, in driving a three-mile tunnel at Inverawe.

The Awe scheme, which is to make use of the water power of an area of over 300 sq. miles, comprises two sections. The first, the Cruachan section, includes pumped storage plant with an installed capacity of 400,000 kW with machinery of a size and type to make it one of the most advanced pumped storage plants in the world. It is considered that in Scotland conditions at the present time are favourable for the introduction of

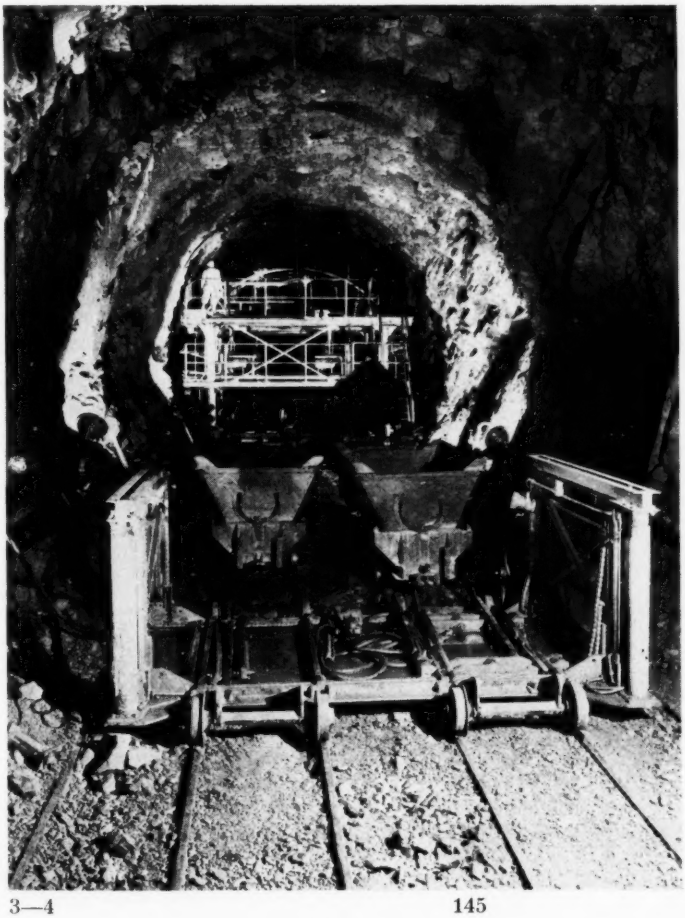


Fig. 1.— Drill Gantry with Car-Handling Arrangement.

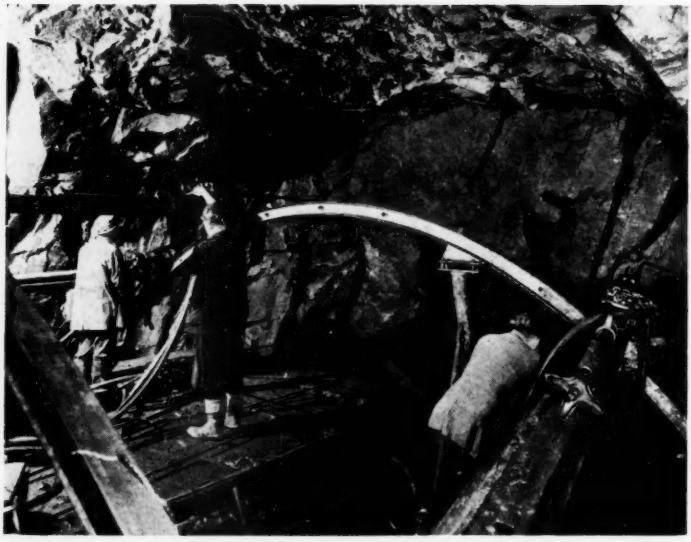


Fig. 2.—Work at Tunnel Portal.

a pumped storage plant for which the requirements are supplies of cheaply produced power at night and peak demand during the day. The Cruachan power station will accordingly be used at night and at weekends to pump water from Loch Awe up to a high-level reservoir from which it will be drawn to generate power at peak demand. A dam is to be built in the corrie on Ben Cruachan at the head of the Cruachan Burn, about 1,000 ft. above the level of Loch Awe. From this reservoir water will be led by shafts to an underground power station inside the mountain and the water conveyed to and from Loch Awe by a tunnel below lock level.

The Inverawe section of the Awe scheme, which is a development of the water power of the River Awe, involves the construction of a low barrage across the river a short distance downstream from the outlet of the loch. From

Fig. 3.—Loaders at Tunnel Face.

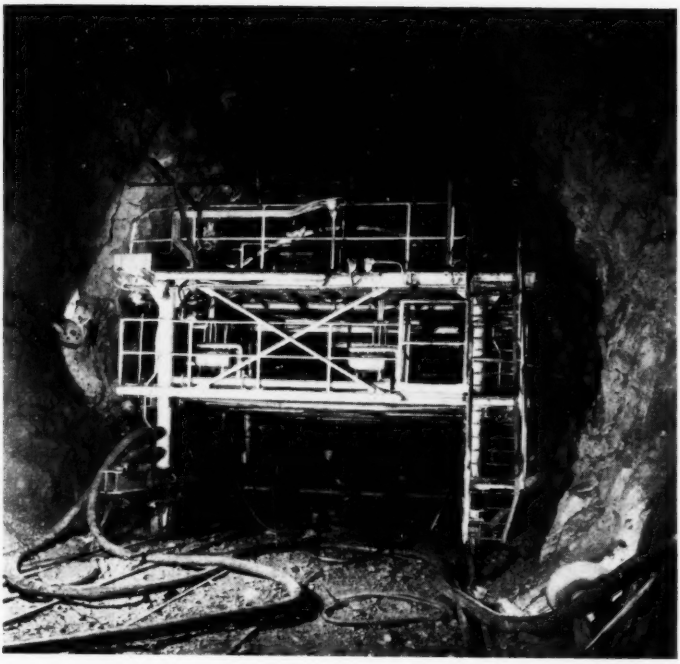


Fig. 4.— Closer View of Drill Gantry.

this barrage water will be taken by a tunnel 3½ miles long and 23½ ft. in diameter passing under the road and railway and through Ben Cruachan to a power station situated about half a mile upstream from the mouth of the river. The best site for the Inverawe power station would have been at sea-level on Loch Etive, but it was decided to build it on the river bank so that the outflow would go into the river to attract salmon. The capacity will be 25,000 kW. and the average annual output about 100 million units.

A further section, the Nant, involves the construction of a dam 1,150 ft. long and 80 ft. in height at Loch Nant. The water will be taken by tunnel to an underground power station which will discharge into Loch Awe. The installed capacity will be about 18,000 kW. and the average annual output 27,000,000 units.

As has already been noted, the ladder-drill technique was developed by Atlas Copco in conjunction with Swedish contractors and the Swedish State Power Board in an effort to develop a system capable of drilling larger rounds with greater accuracy but using a reduced crew. By it each man in the drilling crew can operate two or more machines although with reduced effort. The system has, of course, other advantages. For example, the drill is securely held and the steel bit works more efficiently, while the direction of the drill can be closely controlled, leading to an efficient drilling pattern. This brings economies in explosives and improvements in the accuracy of the excavation, so that there is minimum excess spoil to be removed and minimum lining to be placed. At the same time supervision becomes easier, while the steel guide used, with the pusher feed "in line" make longer drill-rod changes possible. It becomes possible, for example, to use only two rods to complete an 18-ft. hole. When the steel has been drilled to full depth the lugs on the top side of the piston foot can grip on the ladder rungs, so that the retraction power of the pusher can be utilized to extract the steel from the hole.

Before the Inverawe tunnel was started Wimpey engineers visited Sweden to see the system at work. In the event the tunnel, which is being excavated to a diameter of 25 ft., preparatory to lining to 23 ft. 6 in., is now the largest of its type in this country. In spite of this the 13-man crews working on two 12-hour shifts have been able to regularly

pull an 11-ft. round in 11 hours. A 94-hole wedge-cut round is put in by 10 men using 14 machines equipped with ⅞-in. hexagon tipped steels with one change of steel per hole.

Drilling, loading, and firing has been done in as little as three hours. 480 lb. of explosives are being used each round as an average to bring down 550 tons of granite. The contractors are pulling down between 20 and 21 cu. yd. per ft. While "Gelamex" is used for the main holes the periphery is blasted with an explosive containing a lower percentage of nitro-glycerine.

The rail-mounted drilling gantry in use in the tunnel was specially designed to suit the ladder method and in Fig. 1 it is shown in use, with the Wimpey-designed hydraulic cross-over mechanism for the mine cars. Immediately behind are the two Atlas Copco LM250 loaders each with a mine car coupled up. Fig. 2 shows the top level of the gantry at the tunnel portal with the drills supported by the curved beams that follow the soffit. The centre platform of the gantry can be raised hydraulically.

Two of the Atlas Copco LM250 loaders being used for mucking-out are shown at work in Fig. 3. These loaders work simultaneously on the muck-pile and throw backwards into a skip which is air-winched on to the cross-over mechanism and automatically coupled up. The two loaders shown are arranged for right-hand and left-hand operation respectively. There is also a dual-control machine in the store. Bucket capacity of the LM250 is approximately 1 cu. yd. and the mine cars in use are 12 ft. long overall, with a capacity of approximately 5 cu. yd. In one timed mucking cycle 610 tons of fragmented rock (318·7 cu. yd.) were loaded in 121·92 min.

The Inverawe tunnel is scheduled to be finished in three years, from the early summer of 1960. It forms part of a three-section power-station project promoted by the North of Scotland Hydro-Electric Board.

Western Australia and Its Minerals

G. Spencer Compton, B.Sc., A.W.A.S.M.

The author foresees a favourable future for the State as a supplier of minerals

To most people a glance at the map would do little to bring a realization of the great size of Western Australia—a fine mineral province of nearly 1,000,000 sq. miles, equal to one fifty-fifth of the land surface of the whole globe. To some the province will be known as a producer of gold; to others it may be known for some other reasons. Its real importance in the scheme of things, however, has been realized by too few.

The gold industry in Western Australia had its beginnings a little before 1886, in which year there was the first recorded production—a mere 270 fine oz.—but rapid strides were made in the next few years, to reach a maximum yield in 1903 with 2,064,801 oz. The grand total to December 31, 1960, is now 61,500,000 fine oz.; of value £A442,500,000.

The great Colony (as it then was) of Western Australia was founded in 1829 and a few handfuls of people commenced the development of a very large slice of land in circumstances that were a long way from easy or favourable. They managed to make some progress, but in more or less isolated pockets of settlements with restricted agricultural-cum-pastoral activities and poor marketing facilities and poorer communications. Here and there arose a man of vision—one who could see the right course, or could visualize the prosperity that lay in the future; such men "rose from the ranks" as it were. The patient, hard-working, and adventurous pioneers, who took their lives in their hands, ventured them, with their few possessions, into areas well-removed from the few established early settlements—an era of discovery and exploration. After the discovery of gold there was a certain inflow of population, but mainly to the Kimberley and far North-

West areas, both within the tropics where conditions were most difficult. It was in 1887 that the first discoveries of gold were made, in the Yilgarn (270 miles east of Perth), and the tempo of things did improve. Even so, in 1891 the population of the whole colony was only 49,780 persons. Coolgardie's gold find came in 1892, well-supported by the Golden Hole and Wealth of Nations finds in 1894, Hannans Find (which became Kalgoorlie) in 1893, with Kanowna and Kurnalpi in the same year, and Norseman and Menzies in 1894. Earlier, however, there had been the gold rushes to Nannine, Cue, and Day Dawn, Mount Magnet on the Murchison (1890–92), and then to Leonora and Laverton in 1896. By October, 1895, the population of the State had grown to 100,000 such was the lure and attraction of gold! Nearly all the places named would have been familiar to many in the years gone by—the names well-known in the Golden Age of Western Australia. The find at Hannans led on to " the Golden Mile " of Kelly, Brookman, and Pearce, of Cammilleri, of Cross and Revill, and of Sutton, Pung, and others ; where now the four great steady and consistently reliable units[1] produce their regular 40,000 fine oz. per month. Then it was a total of more than 2,000,000 tons of ore for a little better than 500,000 oz. per annum, together with some silver and pyrite. The last-named is now being marketed and should not be overlooked.

It was gold, however, that set up the Colony, which in 1901 became a State under the Commonwealth of Australia, but the agricultural and pastoral industries grew and progressed over ever-widening areas and timber and many other products found markets in the world's merchandizing. The State became better known and population was steadily attracted but it was not enough. It was still gold that made the developments of the out-back areas possible, which favoured the long lines of railways reaching out into the interior and gave the inhabitants the Water-Pipe Line to Kalgoorlie (opened in 1903).[2] Improvements in the great areas of wheat lands set up a wide and intricate system of roads and railways of many hundreds of miles. As a result a number of ports were greatly improved to provide overseas and interstate shipping points, at Fremantle (and Kwinana), Geraldton, Bunbury, Albany, Esperance, Port Hedland, and elsewhere.

The accent thoughout the last 70 years has been undoubtedly on gold, but there have been important amounts of copper, tin, and lead—all useful but without the development of any really permanent or large-scale deposits or centres.

Coal was discovered and worked at Collie (in the south-west) and the production has now reached 30,000,000 tons. It is the fuel for the long-distance railways and for the power stations which have come into existence. It is also the fuel for general industry. There is, of course, some competition with diesel fuel for the railways, while successive governments have made strong endeavours to obtain their coal needs at the most favourable rates in order to offer the best possible power figures to new industries.

Production of coal at Collie has some direct and close connexion with the gold industry, since some 4,000 tons per month is railed to Kalgoorlie-Boulder for the Power Corporation which delivers a proportion of its electrical output to several of the mines of the Golden Mile. Coal has for some time replaced the bush-wood or " firewood " of the local forests. To reach Kalgoorlie the coal travels 490 miles, so the freight is an item and there is a very narrow margin (if any) between the use of coal as fuel and fuel oil that can be landed at Esperance, the port, only 250 miles away.

In the past few years Esperance has become a greatly improved port ; it is also an oil terminal. Other oil terminals in the State are Fremantle (and Kwinana), Geraldton, Bunbury, and Port Hedland.

Fuel oil could be used to a greater extent at Kalgoorlie, but in that event either the Power Corporation or two of the mining companies would have to face considerable capital outlay in providing the necessary power units.[1]

To summarize the main industries and productions and occupations for the whole State, with respect to the remainder of the Australian Commonwealth, the position at present is that Western Australia in 1960

[1] Great Boulder Gold Mines Ltd. ; Lake View and Star Ltd. ; Gold Mines of Kalgoorlie (Aust.) Ltd. ; North Kalgurli (1912), Ltd.

[2] Nearly 90,000,000,000 gallons delivered since.

[1] Lake View and Star and Great Boulder provide their own power with extensive installations, but Gold Mines of Kalgoorlie supplies only a portion of its requirements from its own power plant and North Kalgurli a still smaller proportion. Both these companies draw on the Power Corporation extensively to fulfil their individual power needs.

produced 78% of the gold, 20% of the wheat (with a bumper harvest), 15% of the timber, 12% of the fruit, 12% of the tobacco, 10% of the potatoes, 10% of the wool, 10% of the pigs and products, and 5% of the butter. At the same time manufacturing industries in all their ramifications are increasing at a fast rate.

The population of the State now exceeds 750,000 and the stage is set for a much more intense tempo of mineral development.

The great area of Pre-Cambrian formations in Western Australia would suggest to all that there should also be large areas that are mineral-bearing, with a very wide range of minerals. For 1960 the value of all minerals produced totalled about £A22,000,000, with gold at about £A13,000,000 and "other minerals" at £A8,600,000. In Western Australia these other minerals are growing fast and many of them are expected to come into their own during this next decade.

Iron Ore.—Iron ore is found in quantity in several deposits, while there are smaller occurrences in many other localities. The deposits have been known for a long time, but for some years there has been a strict Commonwealth embargo against export, which has put a very effective clamp on exploration and development. At this very moment in the State no one knows the amount of iron ore available, but investigations are under way. The great Broken Hill Company has been operating in the Yampi Sound area (Kimberley Coast) for some years and operations are soon to be extended to Koolan Island, with major capital outlay involved. Large quantities of high-grade ore have been shipped to New South Wales—750,000 tons in 1960 of 65% Fe grade, the return to the State being in the neighbourhood of £A1 per ton. During the last few months of 1960 the State Government negotiated with the same company for the establishment of a steel industry, with blast-furnaces and all the units needed, at Kwinana (near Fremantle). In this event the iron ore would be drawn from another very large (and good) deposit at Koolyanobbin (near Southern Cross), where upwards of 100,000,000 tons at 62% Fe are available, with much more to come probably when investigations are nearer completion. So this deposit would also be at the disposal of the Broken Hill company—perhaps at a figure a little more advantageous to the State. In return for the possible signing of a suggested agreement the company wishes to see a standard-gauge railway constructed through from Kalgoorlie to Fremantle (and Kwinana) with a branch line at Southern Cross to take in the Koolyanobbin deposit (about 30 miles) for the transport of the large quantities of heavy ore. (It may not be generally known that although the State railways exceed 4,000 miles in length the gauge is only 3 ft. 6 in.).

The building of the projected standard-gauge railway would link up at Kalgoorlie with the Commonwealth Railway already operating to Port Pirie in South Australia. There are now some further discussions at Commonwealth level concerning the continuation of the standardization to Broken Hill and so linking up with the New South Wales System to Sydney. There are, however, complications, in that the South Australian and Victorian systems are also undergoing standardization, some of the work being already in hand. These railway problems have some immense ramifications and much depends on the outcome of the many conferences and the sway of the decisions.

With Broken Hill control of the iron ore at Yampi (65% Fe) and with Koolyanobbin (62% Fe) practically reserved for their use, there remain yet other deposits that the State considers should be availed of for export, without in any way jeopardizing the Australian steel security of the future. Some of these deposits are in the high-grade class.

The Commonwealth recently offered a modification of its long-standing no export embargo—first, by granting permission for shipment of small parcels of iron ore for testing overseas. In connexion with this it is thought that an alleged large deposit in the extreme south-west corner of the State will find favour with Japanese interests, in conjunction with a product from Collie coal in the form of "char," for a sponge-iron project. It is stated that there would be some 300,000,000 tons of hydrous iron ore available, for which a process of beneficiation would be worked out, to be followed by reduction to sponge iron acceptable and saleable to Japanese interests. At present the project is in little better than the discussion stage.

In another category altogether, however, is the high-grade deposit at Mount Goldsworthy (east of Port Hedland). This is a major deposit needing only improvements of port equipment at Port Hedland for handling; and 50 miles or so of track. In the same way Tallering Peak, close to the port of Geraldton (and others in the same general area) will

become important sources of iron, either for sale abroad or to local interests. One is even now being investigated by drilling.

Iron ore in the State will be found to add up to a very large total and it should be developed to be of some considerable financial benefit to the State.

Manganese Ore.—Manganese-ore deposits have already been worth about £A5,000,000 and steady shipments have been made from both Port Hedland and Geraldton. In 1960 manganese shipped was worth more than £A1,000,000.

Chromite.—It would be unwise to neglect mention of chromite, of which there are some Western Australian occurrences and from which there has been some production. Further developments of these deposits would follow on the opening-up of a steel industry in the State.

Asbestos.—The asbestos of Western Australia is mainly crocidolite. Production has passed beyong the £A7,000,000 mark, with annual figures now in excess of £A1,000,000. Information to hand indicates that steps are being taken to build up a bigger annual turnover to improve transport and communications and to make the area and conditions more hospitable for staff and workpeople. The testing stages for this project have long-since passed.

Pyrite.—While pyrite has been used at near-coastal points in connexion with sulphuric acid manufacture and for superphosphate, the greatly extended mineral industry, in conjunction with greater industrial activities, gives an indication that much more pyrite could be absorbed. In the past most of the pyrite used has been produced at Norseman (Norseman Gold Mines, Ltd.) and railed to Fremantle (470 miles), the cost of railage having been an important obstacle to free use. With the coming great development of the Esperance and South Coast country there is very greatly increased agricultural activity. This makes it almost certain that provision of superphosphate at Esperance will be an enterprise of the very near future, seeming thus to suggest a happier and easier future for Norseman and its pyrite and for the Esperance country also, with a local supply of its " super " needs. Railage to the southern port would only be 120 miles, against the 470 miles to Fremantle, as at present. In 1960 pyrite equivalent to 5,500 tons of sulphur (of value £A70,000) was produced on the Golden Mile ; so the Esperance project could well be of considerable interest at Kalgoorlie. The production of copper concentrates at Ravensthorpe (Phillips River) could also be thought to tie-in with any Esperance undertaking.

Beach Sands.—The beach sands of the State are of great immediate interest. There are four major producers in the south-west of the State, with important reserves of titanium oxide (as ilmenite and leucoxene). In fact this southern portion of the State is proved to be a zone of large reserves and is now being recognized as such more widely. In the last months of 1960 there was an important development in connexion with titanium—in the visit of technical officers of the Laporte interests and a follow-up of the directorate. This resulted in an agreement between Laportes and the State for setting up a titanium industry (with other chemicals of considerable range) at Bunbury in the near future. Beach sands (with ilmenite, leucoxene, zircon, and monazite) represent a new industry in the State.

Bauxite.—Recent activities of Western Aluminium have shown that there are large quantities of bauxite available quite close to the west coast (near Perth). Japan has shown some interest in these developments and several large trial shipments have been made, both to Japan as well as to Bell Bay in Tasmania, apparently with satisfaction to all.

The role of minerals in the future activities of Western Australia does not necessarily cease with those already mentioned in some detail. Of considerable importance are a number of lesser-known, or less-attractive, materials all still of value in a balanced and integrated set-up. An extension of talc mining is possible, for example, as a result of recent moves in connexion with a large deposit of excellent material at Three Springs and of a steatite occurrence at Mount Monger (near Kalgoorlie). There are good possibilities in the large magnesite deposit at Bulong (also near Kalgoorlie) and at Ravensthorpe. There could be much greater interest in the glass sands at Lake Gnangara (near Perth), in gypsum, glauconite, beryl, feldspar, and in minerals of the tantalum-niobium group, as well as others to which only slight interest attaches at the moment.

The question might well be asked : " What other minerals does the world seek or need at present—lithium, vanadium, mercury, or tellurium ? " Western Australia could possibly proffer a locality and offer a supply !

Asbestos-Cement Pipe Plant

A. Hegarty

The author describes a new continuous process plant in Texas

The Johns-Manville Corporation recently opened the first continuous-process asbestos-cement pipe plant in the United States at Denison, Texas. The plant is situated on a 469-acre site on the banks of the Red River, which separates Texas from Oklahoma, and puts to industrial use land formerly restricted to farming and pecan growing. It adjoins the 1,300-mile man-made Lake Texoma, the ninth largest water reservoir in the world.

The plant consists of five one-storey steel, concrete, and corrugated Transite buildings on a 469-acre tract. All the production equipment and process layouts were designed by the Johns-Manville general engineering department to performance specifications of the pipe division. The new plant utilizes the latest production techniques based on manufacturing experience dating back to 1904 when Johns-Manville first introduced asbestos-cement Transite in flat sheet form and from 1929 when Transite was first fabricated in tubular shape.

The continuous-process pipe machine, designed by Johns-Manville engineers, includes a double press arrangement which allows formation of pipe at two alternating stations to which pipe mandrels are magazine-fed automatically. A very rough description of the process could compare it with the old multi-barrel Gatling gun. Complementing the rapid-electronic-controlled operation of the continuous-process pipe machine is a completely automatic system of moving raw materials in bulk through a system of conveyors, chutes, and pneumatic conveying pipes. An electronic control device automatically weighs, conveys, and mixes all raw materials and serves them to the continuous-process pipe machine allowing uninterrupted operation.

Clean air and water are assured at the plant by special controls engineered to govern normal industrial wastes. Special equipment using the vacuum-cleaner principle collects dust generated in the manufacturing process.

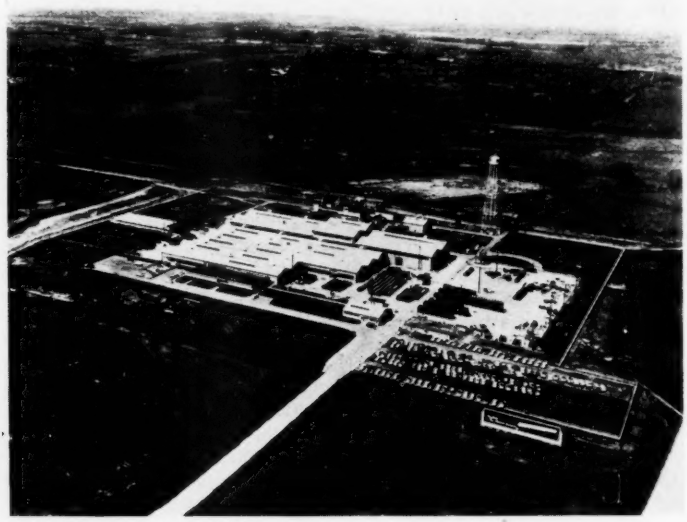


Fig. 1.— New Plant on the Red River.

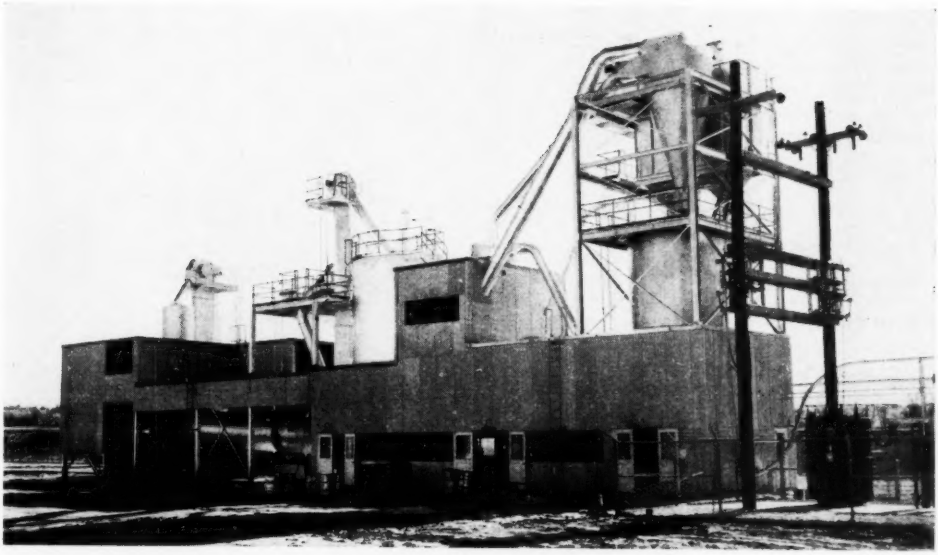


Fig. 2.—Silica Grinding Plant.

Effluent from the plant and all process water is cleaned before being returned to the Red River by passing through a system of settling reservoirs that provide gravity filtration.

The main plant building covers four acres. It provides more than 186,000 sq. ft. of manufacturing and warehousing floor space. The structure is of peak-roof, single-storey design with reinforced concrete foundations and floor slab. The frame is of structural steel.

The roof is of J-M corrugated Transite with built-in translucent corrugated sections permitting direct outdoor lighting. The feature is carried into the wall construction

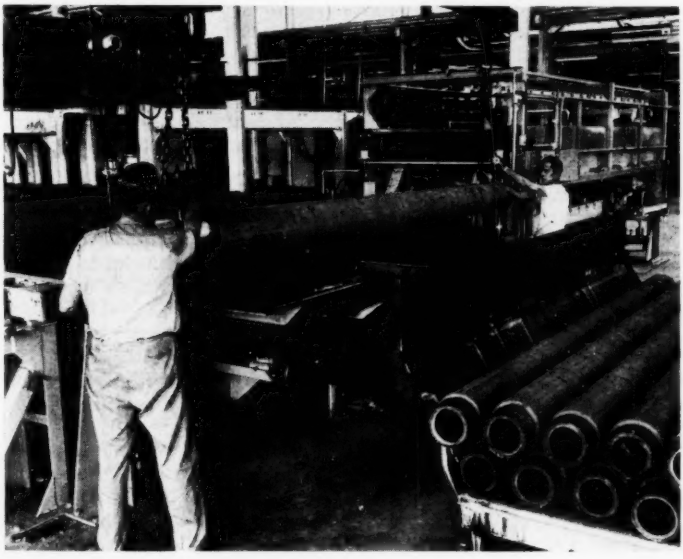


Fig. 3.—Handling Pressure Pipe.

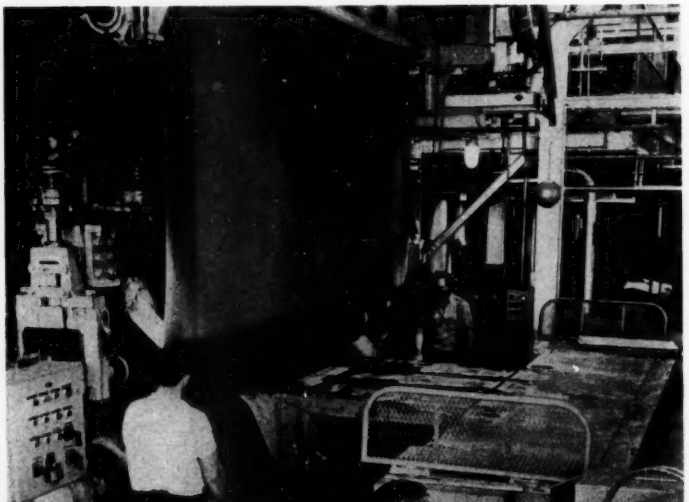


Fig. 4.—Control Arrangements in Pipe Plant.

which contains wide translucent sheets that make daylight operations possible inside the plant.

An area of 26,400 sq. ft. has been set aside in the main plant building for storage of raw materials—asbestos fibre, cement, and silica. A concrete slab and asphalt paved storage area of 185,000 sq. ft. is assigned outside the plant building for the storage of finished pipe products. Heating and ventilation is provided by unit heaters and roof vents, placed strategically throughout the plant to equalize heating in the winter and air-cooling in the summer. Outside temperatures average 43° in January and 84° in July, with a mean annual temperature of 65°.

The main fuel source of the plant is natural gas supplied by a Texas Power and Light Company pipeline. Natural gas is used to fire the plant boilers and the sand-drying unit in the silica grinding operations. Oil stored on the plant property in a 10,000-gallon tank provides an emergency fuel supply.

Compressed air is supplied by two 100-h.p. Worthington reciprocating air-compressors, delivering 650 cu. ft. at 100 lb./sq. in. with distribution through a 4-in. pipeline. The air is used to operate the Fuller-Kinyon conveying system and the pneumatic units of the production equipment, as a booster to the gas flame in the plant boilers, and in the silica grinding unit.

Steam at the new plant is generated by two Union Iron Works MH-type package boilers using 30,000 lb. per hour at 150 p.s.i. Steam is used in the pipe-curing facilities and heating units.

Process water required for the plant is supplied from the Red River through a pumping station. Most process water is pumped directly into the manufacturing system. In addition, a small amount of

water is drawn to a 50,000-gallon watersphere where it can be served into the manufacturing process or sprinkler system by gravity flow. Domestic water is supplied by an artesian well drilled on the plant property.

One of the principal ingredients used in the manufacture of Transite pipe at the new plant is the asbestos fibre. This is shipped into Denison from Johns-Manville mines in Canada. Most of the fibre comes from Asbestos, Quebec, where Johns-Manville owns and operates the Jeffrey mine, said to be the largest asbestos mine in the world. This one mine produces over half of the asbestos fibre mined in Canada or about one-third of the world supply. Some of the fibre used in Denison comes from Matheson, Ontario, near where Johns-Manville operates the Munro mine, producing a special type of high-grade fibre.

The manufacture of Transite pipe utilizes three basic raw materials—cement, silica (silex), and various grades of asbestos fibre. The " mix " varies, depending upon type of pipe required. Almost no manual labour is used in handling these heavy raw materials in bulk. Instead, a system of conveyors, chutes, and pneumatic conveying pipes transport the basic ingredients in an automatic electronic system controlled by push-button. Cement arriving either by hopper truck or railway hopper car from Texas dealers is unloaded by gravity into bins. From these temporary storage areas a Fuller-Kinyon pneumatic conveying system literally blows the bulk cement into four 750-ton process storage tanks to await movement into production.

The " silex " required in the manufacturing process is ground at the plant from Texas sand delivered by trucks. The trucks are gravity unloaded into bins serviced by bucket elevators which convey the bulk sand to a surge tank. From the surge tank the sand is gravity fed to a gas-heated dryer which automatically deposits dry sand in a 200-ton storage hopper. From dry storage the sand feeds out to a Patterson rotating ball-mill where it is ground into silex, a finely-divided silica material. The finished silex is pneumatically conveyed through a pipe to a classifier screen where the proper production size is accepted and fed to a 200-ton storage bin. From this storage bin the silica is conveyed to two 75-ton process storage bins by the Fuller-Kinyon pneumatic conveying system to await movement into production.

Asbestos fibre from Canada, Africa, and Australia arrives at the plant in freight cars and is moved to the fibre storage area by fork-lift trucks. When required the asbestos fibre is again moved by fork-lift truck to a fibre processing area where it is blended and processed. It is drawn by air to production fibre storage bins to await movement into processing.

All ingredients are then in their proper positions to continue moving automatically into the manufacturing process. A large electronic control board takes over, automatically weighing, conveying, and mixing all raw materials and serving them to the continuous process pipe machine which produces Transite pipe automatically without interruption.

Electronic controls built into this automatic system of moving raw materials assure accuracy and maintain required high standards of quality.

Ore-Dressing Notes

(8) *Filtration.*

Notes on Practice

Writing in *Mining Engineering* for January Emmett and Dahlstrom review current practice in continuous filtration and discuss some of the problems of precipitation technique. Most precipitates present special difficulties connected with the slowness of filtration and the need for thorough displacement of filtrate and these problems are on the increase with the extended use of chemical extraction in the processing of minerals. The drum filter, with various modifications, continues to lead practice, being the most adaptable appliance. Where the ordinary air-blow discharge is unsatisfactory and the cake is fairly cohesive and easily brought to a thickness of $\frac{1}{4}$ in. or more string filters have gained ground. The individual string loops run round the drum and are led off, carrying with them the cake, to a discharge roll and then back to the descending side of the drum. Blow-back of filtrate in the drainage section is thus eliminated. With a cake prone to crack or one containing abrasive material strings may be unsatisfactory, while the cost of string replacement becomes an expensive item when frequent attention is needed.

With gelatinous precipitates roller

discharge may be used. The roller bears upon the filter cake and turns inward to it at the same peripheral speed. Cake is transferred to the roll which may be operated so as to carry an inch or so of filter solids on which the transferred cake is received. The removing scraper then planes off the newly-arrived material. An air blow on the main filter drum may be used to aid transfer, in which case the further advantage of better cloth permeability (lost with string discharge) is retained. Thinner cakes can be removed when a roll is used and operating labour is lower. If the feed varies from tacky to granular the use of the roll may be unsatisfactory since a gelatinous quality is needed for good action.

The continuous-belt drum filter is one in which the filter cloth or other media leaves the drum much as does the string discharge and then goes over a discharging roll, an aligning roll, and a return roll, which directs it back on to the descending side of the drum to which it is sealed at the ends by a pliable rubber ridge. While thus detached, thorough washing from either side of the cake, or further chemical treatment, is possible. Changing of the filter cloth is speedily accomplished. The system is especially useful with feeds which blind the cloth rapidly with thin cakes and those which adhere tenaciously and are best removed by sluicing. Because some of the material may remain suspended in the wash water provision for its recovery may be needed unless this wash solution can be recirculated.

Another possibility is the heavy pre-coating of the drum filter. Diatomaceous earth up to a thickness of 3 in. is used as the filter medium and the cake is trimmed off by a knife which shaves off a very thin layer of the pre-coat at the same time, being geared to advance a thousandth of an inch or so per drum revolution. This filtering arrangement is good with very dilute suspensions or slow-filtering feeds which do not form a cake suitable for discharge by the methods mentioned above. Excellent clarification of the filtrate is obtainable and the system adapts itself well to varying conditions of feed. The product is, however, contaminated by pre-coat material and the cost of this medium is higher than for textiles. It is ruled out where the filtrate could crystallize in the pre-coat or attack it chemically.

The authors point out that with hundreds of filtering media to choose from selection of the best cloth for a given process is difficult. Broadly, synthetic fabrics are better for precipitates than natural fibres. Fine and slimy material is best arrested on thin tight twill or satin-wove fabric with a thread count of 150 by 100. Somewhat coarser materials can be treated on thin plain-woven fabrics, preferably twills. Precipitates widely ranged in size, including slimes, are best caught on mono-filament cloths.

(9) *Production.*

L.P.F. at Miami

The leach-precipitation-flotation process was first considered as a method of treating the mixed sulphide-oxidic copper ores of Miami, Arizona, test work starting in 1929, the term " oxidic " used here covering copper oxides, carbonates, and silicate. The original full-scale operation (1934–1943) and the revived one (1957–1959) are reviewed by J. J. Bean in *Mining Engineering* for December, 1960. During the development of a suitable treatment difficulty was experienced in separating the acid-leach solution from the leached residual minerals. As a result the idea of precipitating the dissolved copper on to iron and recovering it together with the copper sulphide in the ore was tried out. It was developed into a commercial operation which treated nearly 10,000,000 tons of ore in nine years. In the finalized process the copper sulphide minerals were first floated from a lime-alkalized pulp with sodium ethyl xanthate and pine oil. The tailings from this operation, in which chrysocolla was the dominant copper value, were then thickened to between 40% and 50% solids and leached with sulphuric acid in air-lift agitators. The copper was next stripped from the pregnant solution during passage over de-tinned and shredded cans kept agitated in wooden drums. The precipitated (" cement ") copper which resulted, together with sulphide copper which had hitherto been unresponsive to flotation, was then floated from a lime-alkalized pulp with Minerec A and pine oil. In 1943 on exhaustion of the ore-body for which this treatment had been evolved, the plant was shut down and the precipitation drums were adapted for handling solutions from leaching *in situ*.

Mining of low-grade ore recommenced in 1954. Sulphidization treatment for flotation of the oxidic copper minerals, in which chrysocolla continued to predominate, proved unsatisfactory. Laboratory work, therefore, turned to the trial of a two-circuit flow-sheet

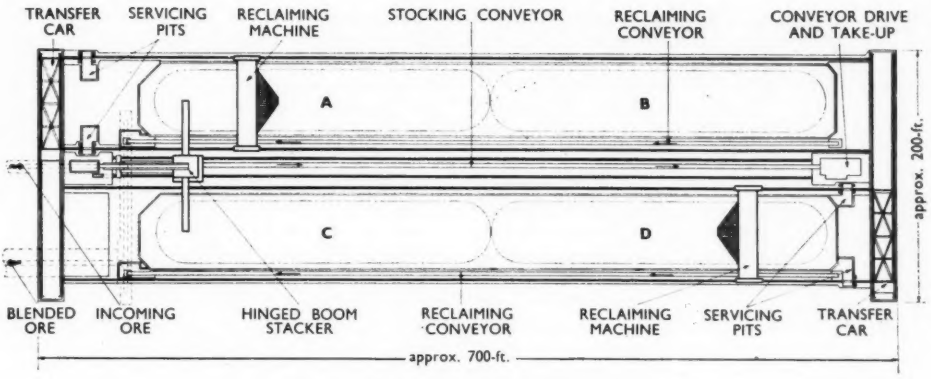


Fig. 1.—Blending Plant Arrangement.

in which sulphides would first be floated and next oxides. The best resulting concentrates only assayed 7% of copper so the possibility of L.P.F. methods was investigated. In the end the pre-war treatment was re-established. The laboratory tests were best with a 30-minute agitation of thickened sulphide-float tails at a pH of 1·5, maintained with sulphuric acid. Copper was then precipitated on powdered iron during five minutes of agitation. Values were next floated with Minerec A and xanthate collector and methyl iso-butyl carbinol as frother. This treatment proved applicable to all the ores treated during a month's full-scale test. Only tailings relatively high in oxidic copper were sent to the rehabilitated pre-war plant, the head assay averaging 0·4% sulphidic and 0·5% oxidic copper. The work continued until 1959 when economic considerations led to a shut-down.

(10) *Handling.*

The Robins-Messiter System

In the Summer, 1960, issue of the *G.E.C. Journal* there is a detailed description of the Stanton Ironworks Co's blending plant which was completed in 1959. The Robins-Messiter system was originally developed on copper ores and products, but during the past 20 years its use has been extended to other minerals, including iron ore and coal. At Stanton ores from a number of sources, some of which are foreign, must be blended before smelting in order to maintain an even chemical composition and peak efficiency during the treatment of some 35,000 tons weekly. Incoming ore is crushed to *minus* $2\frac{1}{2}$ in. and then blended. The system (Fig. 1) receives this crushed material and forms it into one or more pairs of long prism-shaped beds. Feed is delivered *via* a longitudinal conveyor-belt to one of a pair of travelling cross-belts (stackers). This belt delivers to the apex of its bed. As the stacker moves longitudinally over the forming bed, backward and forward, a series of thin layers of ore is built up. When sufficient laminae of the various ores coming into the plant have been built up into a long bed they are rabbled together in a further mixing as they are fed to the reclaiming machine which takes over from the stacker. Stacking meantime proceeds on the other wing of the feed section conveyor. A complete bed at Stanton holds 15,000 tons in a pile 56 ft. wide at the base and 21 ft. 6 in. high. The rate of building is 600 tons per hour.

Each of the two reclaiming machines has a capacity of 300 tons per hour and consists of a bridge which spans the bed and is carried on tracks that allow it to be driven face-on into the cross-section of the pile. The bridge houses the driving and control gear and supports a triangular harrow. This harrow combs the cross-section of the pile with steel teeth set at 7-in. centres with a side motion of 24 in. and an oscillating rate of 26 strokes a minute. The rabbled material falls to a plough conveyor set across the base of the pile and carried by the bridge. This pushes the dislodged ore to a longitudinal conveyor running along the flank of the pile, as the slowly-moving bridge eats its way forward. The speed of the bridge is adjustable between $\frac{1}{2}$ in. and 5 in. a minute forward and it can be retracted at 30 ft. a minute during which operation the plough conveyor is jacked clear.

Book Reviews

Kempe's Engineers Year-Book, 1961. In two volumes in case (3,000 pages), illustrated. Price 87s. 6d. *plus* 2s. 6d. postage. London: Morgan Brothers (Publishers), Ltd.

The current edition of this Year-Book provides as usual a comprehensive coverage of modern theory and practice in practically all branches of engineering. The 79 chapters have been closely checked and there has been a considerable amount of revision. The "Motor Vehicles" chapter (replacing "Road Vehicles"), that on "Forging Hammers and Drop Forging Plant," and the "Heating" section of chapter "Heating, Ventilation, and Air Conditioning" have all been re-written. Major revisions have been made to the chapters "Heat, Optics, etc.," "Hydraulics (Mechanics of Fluids)," "Units of Measurement," while valuable additions have also been made to other chapters. Alterations and additions due to the issue of new and revised British Standards have also been included. The work remains its usual self—an up-to-date treatise which can be consulted with confidence.

Mechanized Cutting and Loading of Coal. By R. SHEPHERD and A. G. WITHERS. Cloth, octavo, 328 pages, illustrated. Price 50s. London: Odhams Press, Ltd.

This excellent reference work provides an authoritative survey of modern mechanized handling at the coal face by two recognized experts, the first from the Mining Department at Sheffield University and the second formerly senior mining investigator to the British Colliery Owners' Research Association. Efforts to reduce manual labour underground and to combat a decline in available manpower have in the past decade naturally accelerated the progress of mechanization. It is natural, therefore, that the authors give first a historical account of their subject before proceeding to classify the various types of coal-cutting machinery and discuss the principles of coal breakage. There follow descriptions of the basic cutters available before sections devoted to electricity, safety and health, the choice of equipment, operational problems, and examples of installations and experiment. Chapters on "Other Mechanical Means of Coal-Winning" and "Mechanization and Efficiency" precede a final discussion on "Future Trends," concluding an excellent book, which will be of interest to all concerned in the development of the coal-mining industry.

Ultraviolet Guide to Minerals: Including Field Identification Charts. By STERLING GLEASON. Cloth, octavo, 244 pages, illustrated. Price 52s. 6d. Toronto, New York, London: D. Van Nostrand Company, Inc.

A popular guide to the use of ultraviolet light in the location and identification of minerals, this handsome handbook, with coloured illustrations, will be of use to the amateur and professional alike. In four chapters the author describes the utilization of fluorescent methods in mineralogical work before giving, in Chapter V, "Recognizing the Minerals," a series of tables (occupying 118 pages) designed to help. There follows a number of chapters discussing the uses of fluorescent detection, with two final sections devoted to test work and the outlook for expanded use of the technique.

☛ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Oolitic Ironstones of Fresh-Water Origin

A Review of a Russian Monograph

In the extensive geological literature on oolitic ironstones little has been written on occurrences of fresh-water origin. A special interest therefore attaches to a recently published monograph by the Russian geologist A. L. Yanitsky,[1] who has given the first full description of a widespread group of oolitic ore deposits of fluviatile, deltaic-lacustrine, and lacustrine facies studied in Kazakhstan from 1949 to 1956. In view of the unusual character of these beds publication of a brief account in English seems to be called for.

The deposits in question lie principally in the northern Turgai and northern Aral'sk districts of Kazakhstan, among continental sediments. They are all of middle Oligocene age and have been formed in low-lying river

[1] YANITSKY, A. L. Oligotzenovye Oolitovye Zheleznye Rudy Severnogo Turgaya i ikh Genezis. [Oligocene oolitic iron ores of northern Turgai and their genesis.] *Trudy Inst. Geol. Rudnykh Mestorozhdenii* [Trans. Institute for the Geology of Ore Deposits, etc.], Moscow (Academy of Sciences), No. 37, 1960, pp. 219, figs. 82. Price 12r. 60k.

valleys excavated on the uplifted surface of the marine Palaeogene, at a time when the Cretaceous strata and Palaeozoic basement of the Mugodzhary and Ural mountains to the west were undergoing deep weathering. The climate of the middle Oligocene was warm, almost sub-tropical. The mountain districts from which the rivers were fed were covered entirely by forests and the river valleys themselves were densely wooded.

Locally in the ironstone deposits shells of the fresh-water mollusc *Pisidium* have been encountered. Fossil plant remains in the form of drifted tree-trunks, branches of trees, other vegetable trash, spores, and pollen grains are much more abundant and include species of *Ginkgo*, *Cyathea*, *Pinus*, *Taxodium*, *Cedrus*, *Sequoia*, *Salix*, and a dozen other genera from the study of which the ironstones are firmly related to the Kutanbulak series of the middle Oligocene. At the largest, Lisakovsk, occurrence which extends along a former river valley for a length of 100 km. with a breadth of from 2–3 to 7–8 km., the oolitic ironstones have been deposited not only in the river channels but also in marsh and lake-swamp environments. Since the river courses were wandering and intermittent, stream deposits may cut through ore-beds of lake type and *vice versa*.

The deposits formed in the old river valleys include quartz gravels, shingle, and sands, all bearing ooliths dispersed throughout, siltstones, oolitic ironstones, and clays. The commonest development is oolith-bearing quartz sandstone containing seams of hydrogoethite oolitic ironstone. Traced upstream the river detritus becomes coarser, silts passing laterally into sands, shingle, and gravels. The lacustrine and deltaic-lacustrine deposits are principally medium- to fine-grained quartz sands with hydrogoethite ooliths, siltstones, clays, and oolitic ironstones bearing banded hydrogoethite-chlorite ooliths usually bound by a sideritic and chloritic cement. Many of the ores, with abundant hydrogoethite, have been formed in an oxidizing environment, but others with banded hydrogoethite-chlorite ooliths in a chlorite-siderite cement bear witness to alternating conditions of oxidation and reduction.

In chemical composition the ironstones exhibit the range 29–73% Fe_2O_3, 0·6–2·5% P_2O_5, 0·6–1·6% CaO, highly variable SiO_2, and consistently about 0·04% ZnO. For commercial purposes the ores have been classified into three groups: Grade I, with Fe above 40%; grade II with Fe 30–40%, and grade III (at present non-payable) with Fe 20–30%. In the oxide ores the content of hydrogoethite ooliths ranges from 30% to 80% or more. For the most part they range in size from 0·25 to 1·00 mm., being coarsest in the shingles and gravels.

The oolitic ironstones of fluviatile origin have been mapped as long ribbon-like strips extending along the ancient river valleys sometimes for many tens of kilometres. The higher-grade ore zones take the form of elongated lenses with the same orientation, some hundreds of metres in length. In the lacustrine and paludine deposits the sheet-like masses of ore possess a more oval outline. Intraformational washouts are frequent, demonstrating reworking of the beds during their deposition; and this has given rise to gravel and shingle formed of fragments of oolitic ore, often with ooliths which have been split across during transportation. In thickness, the ore seams average about 15 m.

In an extensive discussion of the genesis of the ironstones, the author concludes that the formation of the ooliths began contemporaneously with the sedimentation of colloidal iron compounds and was completed at a very early stage of the diagenesis of the rocks.

C. F. DAVIDSON.

Driving Achievement in Northern Rhodesia

Some details have been released of rapid progress recently achieved in a new 14-ft. square haulageway at Nchanga Consolidated Copper Mines. During a 26-day period in July last, with an average daily advance of 47 ft., 8,889 cu. yd. of rock were excavated.

Operations were organized in six-hourly shifts and the best performance achieved during July was two complete cycles in one shift. The drilling arrangements, illustrated here, utilized 18 Holman H.A. 300 Handrils, of which 11 were in use and seven kept as spares with a similar number of $2\frac{3}{8}$-in. bore Holman airlegs having a piston stroke of 52 in. Tungsten carbide chisel bit integral hexagon 1-in. steels were used, the handrils operating at an air pressure of 100 p.s.i. and being used to drill an 8 ft. 9 in. round. A five-hole burn cut was employed and five to six rounds were drilled every 24 hours.

Each round was cleaned in one operation using a locally designed and constructed conveyor system which allowed broken rock to be mucked on to a train of six 25-ton Gregg cars, with the need for shunting operations eliminated.

Engineering Log

A recent paper by Legget and Eden in the Canadian *Engineering Journal*[1] shows clearly that knowledge of soil properties can be fundamentally important and may be recorded cheaply as part of an exploratory programme. The physiography of the Canadian Shield is mainly dominated by glaciation, which removed most of the previously existing surface deposits and changed the whole drainage system. The residual water-laid soils are of three classes—lacustrine sands, varved fresh-water clays and silts, and post-glacial marine clays. The varved clays are widely distributed and occupy former glacial lake basins such as are frequently of interest in mining. When disturbed they liquefy readily into the mud which leads to so many difficulties. " Indicator tests " have been developed which show how the various air-water-soil mixtures may be expected to behave. These determine the natural water content and the point (the Atterburg limit) of change from a plastic to a liquid state under prescribed conditions defined in A.S.T.M. standards. There are also laboratory methods for determining the mechanical strength of natural and disturbed soils, including shear strength. An important criterion is the liquidity index (L.I.) for which an empirical formula has been developed. Fine-grained soil with a high L.I. often appears stable, because its excess water is held in an internal micro-structure. This breaks down after such a soil is disturbed and the resultant running mud can be disastrous. On moulding a sample of such a soil between the fingers it turns liquid. The field engineer who encounters this behaviour within the range of disturbance of proposed works should immediately institute soil studies. Once the threat is recognized safety measures can be taken. Most of this recognition work can be tied in with the prospecting programme. Seismic tests show depth to bedrock and aerial photography displays soil variations and their extent. Water levels in standing drill-holes provide clues, but knowledge of the state of the undisturbed subsoil is important. Access roads, stripping operations, shaft-sinking, disturbance of varved soils by the mounting pressure of a tailings dam, foundation thrusts of buildings and stockpiles are among the mining works liable to be jeopardized.

[1] Nov., 1960.

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The impervious-graphite pumps now being made in the United States are proving well suited for handling corrosive and even abrasive solutions. In metal-finishing operations, for example, the pickling solutions required are of necessity corrosive and graphite pumps handling dilute sulphuric acid are found to have a resistance which gives them protracted life. Acids and combinations of acid do not affect the graphite and the rugged pump units now available can withstand rigorous conditions.

* * *

The cushion of air on which a hovercraft glides above land or water is maintained by supplies from a continuous jet nozzle. This blows air inward from the periphery of the underside of the vessel (or vehicle) at such an

angle that the jet stream bends outward before it hits the water or the ground. The cushion of air then becomes enveloped by the jet stream, the hovercraft, and the surface. Considerable developments are now being made as this process is more completely understood, controlled, and applied. The present stage of study suggests that the minimum all-up weight likely to be commercially competitive is about 70 tons. Two prototypes designed to reach forward toward a craft of this size are now being developed by Vickers Armstrong from Cockerell's original inventions. The first is to have a payload of 1½ tons and speed of 70 m.p.h. and should be in operation later this year. It will provide information on handling, stability, control, and the best use of the system of air jets. The second machine, at present in the project stage, is to carry up to 200 passengers and/or 12 cars, with a range of 200 sea miles and a speed of 90 m.p.h. In view of the complex new problems raised by this revolutionary engineering idea the holiday cross-channel congestion is hardly likely to be relieved this summer by what is expected to be, among other things, a valuable express car ferry service, although it may well be in operation before the proponents of the Channel Tunnel and Bridge get down to brass tacks.

* * *

Remote control of a coal-cutting machine has now been experimentally achieved by the Mining Research Establishment. The thickness of coal beneath the hewing machine is sensed by gamma rays. Using this signal as a control 27 in. of coal has been cut from a 30 in. seam, the dirt content of the severed coal thus being halved as compared with straightforward mechanized hewing. A radioactive source is placed over the floor of the seam and gamma radiation is "scattered" back to a G.M. counter. Thus the bottom 4 in. of floor coal is measured within ½ in. and the machine can be hand-steered along an undulating seam without cutting into either floor or roof. This development, added to such advances as automated coal-face supports already in use in a number of workings, is a further step toward the 1961 target—complete automatic control of the coal face at a cost of between £50,000 and £100,000 per installation.

News Letters

BRITISH COLUMBIA

Queen Charlotte Islands.—Granby Mining has entered into an agreement with Silver Standard Mines for the purchase of the latter's Queen Charlotte Islands iron properties and for the sales agreement negotiated by Silver Standard last autumn with Japanese interests. Granby has made initial payment of $25,000 and is to pay a further $225,000 by April 30 subject to an examination of the ground and study of the work done, the full purchase price being $1,000,000. It is a part of the agreement that a new company—Jedway Iron Ore, Ltd.—be formed and that Granby furnish working capital of not less than $500,000. Granby has further agreed to pay a royalty of 25 cents per ton on any production beyond the 1,000,000 tons now under sales contract.

Also on Queen Charlotte Islands new activity will commence at once on the Tassoo Harbour property of Wesfrob Mines—a subsidiary of Ventures, Ltd. The property is considered to be the largest tonnage and highest grade of any iron deposit on the B. C. Coast. All development was stopped when the Provincial Government imposed its tax on ore in the ground. The rescinding of that policy last autumn has paved the way for further work on the property.

Vancouver Island.—Noranda Mines has negotiated a sales agreement with eight Japanese steel mills for the sale of iron concentrate from the Kennedy Lake property on the west coast of Vancouver Island. The contract, although details have not been made public, is understood to be the largest yet made by any Canadian mining company with the Japanese. It calls for delivery of 700,000 tons of iron concentrate annually at a price of approximately $9·00 per ton. The Kennedy Lake property is being equipped for production as soon as possible.

Yet another British Columbia mine will commence production as a result of the Japanese ore-buying policy. The Cowichan Copper Co., which has exhausted its developed ore at the Blue Grouse copper mine, is to move its concentrator to the property of Sunro Mines, Ltd., near the southern end of Vancouver Island and commence production from a proved deposit. The announcement was made late in January by O. G. MacDonald, Cowichan president, after successful negotiation of agreements with Sunro Mines, Ltd., which is controlled by the Consolidated Mining and Smelting Co. of Canada, Ltd., and with Mitsui and Co., Ltd., for the funds with which to equip the Sunro

property for production. Copper concentrate will be trucked over paved roads the 54 miles to Cowichan's deep-sea wharf and loading facilities at Hatch Point. The indicated ore reserves at the Sunro are estimated at 974,000 tons averaging 1·8% copper; all developed ore is concentrated in one steeply-dipping ore-shoot. There are thirteen indicated ore zones on the property and Cowichan will give some attention to development as well as to production.

New Westminster.—The directors of Pacific Nickel Mines and Giant Mascot Mines have announced jointly that, subject to approval of shareholders of the former company, Giant Mascot will purchase Pacific Nickel's 49% interest in Giant Nickel for $475,000, payable as to $250,000 upon execution of the agreement and the balance in five equal monthly instalments at 6% interest. The deal is considered equitable to Pacific Nickel and at the same time particularly advantageous to Giant Mascot, which will then take over the operation in its own name and thus utilize the $2,601,609 deficit for tax consideration. Since July 7, 1959, to November 30, 1960, Giant Nickel has treated 353,140 tons of ore averaging 1·01% nickel and during the 17 months has earned a gross operating profit of $1,059,000.

Lillooet.—Bralorne Pioneer Mines reports the production of 29,122 oz. of gold from 38,642 tons of ore milled by the Bralorne Division and a partial mill-clean-up recovery of 2,364 oz. gold by the Pioneer Division in the last quarter of 1960. The building to house the new Bralorne cyanide mill has been erected and foundations are being prepared for machinery and equipment which is now arriving at the property.

Hurley River Mines has leased two placer claims covering a length of a mile across the bed of Cadwallader Creek to B. C. Placer Mining and Refining, Ltd., a newly-incorporated company which plans a placer-mining operation by means of a power shovel and specially-constructed washing plant. Spasmodic recovery has been obtained for the past 60 years on Cadwallader by hand methods. The creek flows over both the Pioneer and Bralorne mine properties and the site of the new operation is about two miles below Bralorne.

Bridge River United Mines plans to drive a deep hole from surface to explore the projected position of the Forty Thieves vein at a depth of 500 ft. below the Ural No. 3 adit, the deepest working in the mine. The work is part of a development programme being directed by Rayrock Mines, Ltd., which holds an option to purchase a controlling interest.

Nicola.—Torwest Resources has purchased the Marb group of 70 mineral claims immediately west of the Craigmont copper mine property near Merritt. The purchase was made on the recommendation of Mr. R. E. Renshaw, consulting geologist, who directed all early exploration on the Graigmont ground. An exploration programme has already been commenced by Torwest because of ideal winter-operating conditions obtaining in the area. Renshaw states that geological and geophysical investigation has revealed the Nicola intrusive contact to extend westerly from the Craigmont ore zone across a group of claims held by Rio Tinto Canadian Exploration, Ltd., into Torwest's Marb No. 49 claim, thence in a reverse-horseshoe pattern for 18,000 ft. within the Marb group; two magnetic anomalies have been indicated by reconnaissance surveys. The company has let a contract for 5,000 ft. of diamond drilling and Renshaw has spotted three holes, the first on a projected plane of axial folding near the west boundary of the Marb group, the second above an indicated anomaly on the projected Craigmont fault zone near the eastern limit of the Marb group, and the third at the junction of the projected axial plane of folding and the projected fault zone, north of the Nicola intrusive contact and near the north limit of the Marb group.

Greenwood.—Continental Consolidated Mines has recovered high values in precious-metal-bearing black sand on bedrock of the ancient channel of Granite Creek, near Tulameen. A long tunnel was driven to reach an area below bedrock and the first test hole was enlarged to withdraw a considerable quantity of gravel. When shaken over a table a fine concentrate was recovered which in turn yielded an 80% magnetic fraction and a 20% non-magnetic fraction. The first assayed 0·34 oz. platinum, trace gold, and 0·26 oz. silver per ton and the latter, 1·12 oz. platinum, 3·42 oz. gold, and 2·26 oz. silver per ton. The company proposes to extract the rich paydirt with as little dilution as possible by means of a system of box chutes from the tunnel entry.

Yukon.—During the December quarter, United Keno Hill Mines produced 1,560,600 oz. of silver, 3,937,700 lb. of lead, 3,483,700 lb. of zinc, and 45,600 lb. of cadmium. The company president, Mr. A. J. Anderson, says that the concentrator is now operating at full capacity and reports encouraging results of underground development.

EASTERN CANADA

February 24.

Ontario Gold Output.—During December the gold mines of Ontario milled 783,501 tons of ore and produced 229,639 oz. of gold and 37,560 oz. of silver, together valued at $8,020,961. The December "Gold Bulletin" issued by the Provincial Department of Mines states that during 1960 there were 31 producing gold mines operating in Ontario. All were operating together only in September, that being the last month of operation for one mine and the first month of operation for another. They reported milling 9,338,636 tons of ore which contained 2,667,726 oz. of gold and 434,250 oz. of silver which had a total value of $91,052,972. The average grade of ore for December was $10·24 and there was an average of 10,987 wage-earners employed.

Sudbury.—The Mond Nickel Co., Ltd., an affiliate of the International Nickel Co. of Canada, Ltd., has announced that from February 28, 1961, it is to change its name to the International Nickel Co. (Mond), Ltd. The change, it is considered, serves to identify it more closely with the Canadian company and the United States affiliate, the International Nickel Co., Inc.

Manitouwadge.—Shareholders of Geco Mines have been informed that the estimated profit on operations in 1960 after provision for depreciation and deferred development write-off of $1,949,500 and all taxes is $5,388,500. In the year 1,294,077 tons of ore was milled, the average copper grade of ore being lower than that for 1959. The system of open stopes and pillars used successfully in the "A" zone was also established in the "B" zone. These stopes, it is stated, were designed to supply the bulk of the ore to the mill during 1961. However, two pillars between stopes failed about the end of December and it will not be possible to draw ore from these sources until after the middle of the year. The openings are to be backfilled before drawing further ore. It is expected that the mill tonnage will have to be reduced to around 3,000 tons daily and the grade of ore treated will be lower until this part of the mine comes back into production.

Saskatchewan.—In the review by the chairman accompanying the report and accounts of Borax (Holdings), Ltd., for the year to September 30 last reference is made to the company's permits to explore on certain Crown lands in Saskatchewan. Studies of the possibility of producing potash from these lands are still not finalized.

Quebec.—In an interim report on operations in 1960 shareholders of the Normetal Mining Corporation are informed that production was lower in the fourth quarter of the year, owing to suspension of mining below the 3,070 level from October 9 to November 13 to allow of maintenance and repair on the upper part of No. 4 (internal) shaft. During the period of shaft repair the mill operated intermittently for a cumulative total of 11 days treating ore from above the 3,070 level. In the year 367,164 tons of ore was milled for an estimated profit of $1,356,500.

During 1960 the Quemont Mining Corporation treated 856,632 tons of ore for an estimated profit of $1,999,300.

AUSTRALIA

February 20.

Mineral Investigation Service.—The formation of the Australian Mineral Development Laboratories should give a comprehensive mineral investigation service to Australian mining available to industry, Government authorities, and the general public. The Association is on a national basis and offers a contract service for the investigation of problems relating to the development of mineral resources, mineral processing, and the utilization of mineral products.

Assistance to Metal Mining.—Most of the Australian States provide crushing and treatment facilities for ores raised by prospectors and small-mine operators and also provide assistance by way of assaying, geological advice, drilling, and financial help for approved work. Western Australia is now to make available, on hire, portable air-compressors in the Kalgoorlie, Mount Magnet, and Marble Bar districts. Each compressor will be equipped with a jackhammer, hoses, air leg, and air hoist. The quantity of good-grade ore being sent to the State batteries is a strong argument in favour of the extension of this service to small operators.

Gold.—Although gold production was maintained during 1960 the industry is facing increasingly difficult conditions and it is probable that approaches will have to be made to the Commonwealth Government for increased financial assistance. The margin between realization and costs is becoming less with the granting of each request to the industrial Courts for increased money and shorter working hours. There is now a general application before the Courts for an increased basic wage and the Unions have stated their intention to go "all out" for a 35-hour week.

Despite the depressed state of the industry there is a substantial degree of interest in the search for gold, both by strong companies and individuals. A newcomer into the field is Pacific Island Mines, Ltd., which in 1960 was actively prospecting on Misima Island, Papua. Pacific Island Mines has concentrated on costeaning the lodes discovered in its area and a limited amount of underground work has also been done in the driving of adits along the course of one or more lodes. The company's last report advises that, with the co-operation of the Bureau of Mineral Resources, costeaning is going forward and three new lodes have been discovered. A pilot plant is being erected and the property is regarded as valuable.

In Victoria recent prospecting has located a promising gold occurrence on the old goldfield of Wedderburn and ore broken in the initial prospecting work has returned 4 oz. gold per ton. The field in its early days was noted for the number of nuggets found and the richer gold occurrences were associated with "indicators" which were a feature of many of the Victorian goldfields, particularly Ballarat.

Gold mining in Fiji is at a stage where capital is needed for the development and equipment of the new ore-bodies which have been located at Emperor Mines, Ltd. There ore-bodies are narrow and, therefore, their development calls for capital. The Fijian Government, recognizing the importance of the gold-mining industry to the Colony, granted the company a subsidy, but the stage has been reached at which it is evident that the resources of the company's mine in new ore occurrences are much greater than had been originally supposed. To assist toward the new capital requirements the Fijian Government was approached for an increased subsidy, but is not prepared to extend the subsidy beyond the present agreement because of deterioration in the Colony's financial position. Efforts are to be made to secure capital to bring the mine to an economic level of production.

Clay.—There is evidence of overseas interest in Australian clay deposits, the domestic consumption of clay and shale increasing by about 400,000 tons in the past 12 months. Australia, unfortunately, is deficient in reserves of white clay, the kaolin deposits known being underground mining propositions. Consumption of clay in the manufacture of cement is increasing with the growth in cement manufacture and is likely to increase for a period if there is no recession in the construction field. There are extensive clay-bearing areas in south-western New South Wales which have not yet been exploited to any marked extent, but the State Government has carried out investigations into resources and is about to commence a large-scale drilling campaign in the south-western region and at localities on the east coast.

Coal.—The chairman of the Australian Coal Association has stated that exports last year were 1,550,000 tons, worth £A6,000,000. He considers that this figure could be doubled within two or three years if terminal ports were constructed to world standards. He stressed the need for new ship-loading plants capable of handling 3,000 tons of coal per hour, at Sydney, Newcastle, and Port Kembla and said that until these are built the coal industry will be severely handicapped. Australian coal ports must be capable of accommodating ships of 30,000 tons to 40,000 tons.

The urgency of modernizing the coal ports has been stressed for some time. The mining side has been developed rapidly to a very high state of efficiency and in the last year the New South Wales output of black coal increased by 2,000,000 tons to 23,000,000 tons. Output can be further increased and this advance in the industry, which has resulted from mechanization, could be heavily handicapped by restriction of the export trade. There is now a proposal to construct a coal loader at Newcastle capable of handling 2,000 tons per hour, at a cost of £A3,000,000; this loader would be capable of accommodating ships of 40,000 ton capacity. The proposal will be considered by the Maritime Services Board.

Aluminium.—It is reported from New Zealand that tenders are to be called by the Consolidated Zinc Corporation, Ltd., for the first construction work in connexion with the aluminium project to process bauxite from Weipa, North Queensland, at the reduction plant to be erected near Invercargill. This initial work will include the driving of an exploratory tunnel, 700 ft. to 800 ft. long, to the west arm of Lake Manapouri for the purpose of testing the rock and examining the structures to be passed through. It is expected to complete this first part of the power project this year.

Oil and Natural Gas.—In New South Wales the Australian Oil and Gas Corporation, Ltd., which has done considerable exploratory work, has commenced the first full-scale seismic survey to be undertaken in the State in the search for oil and gas. The survey will cover 1,500 sq. miles and take six months to carry out.

The oil discovery problem is one of the most important facing Australia and is being pressed on by private and Government interests. A seismograph survey is to be carried out this year in South Australia and Queensland by

Santos, Ltd., and Delhi-Australian Petroleum, Ltd., under contract by N.A.M.C.O. International, of Texas. Operations are to be commenced in March. The work is to be completed before any further bore-holes are located.

Iron Ore.—The lifting of the 23-year old embargo on the export of iron ore has already been productive of considerable interest in the export of ore, particularly from Western Australia. Policy regarding the Scott River iron-ore deposits in the south-west of Western Australia is not yet clear. This recent discovery of limonite is tentatively considered to contain some 200,000,000 tons of ore, but no comprehensive or adequate survey has yet been completed, so that the possibilities of this deposit in regard to tonnage and grade are at present unknown.

Development of the proposed £A45,000,000 iron and steel project of the Broken Hill Proprietary Co., Ltd., at Kwinana, near Perth, appears to hinge largely on the decision of the Commonwealth Government to build a standard-gauge railway from Kalgoorlie, through Koolyanobbing, to Kwinana, to handle ore, fluxes, fuel, and products and a decision is awaited.

FAR EAST

Events of 1960.—China's steel, iron, and coal output in the first half of 1960 was considerably higher than in the equivalent period of 1959, yet exactly what happened in the second half of the year is not yet clear but a setback is indicated in the news from Peking that "an exceptional series of natural calamities" greatly affected "all branches" of the economy. In three provinces, for instance, floods caused a suspension of steel, iron, and coal production. The steel target in 1960 was 18,400,000 tons by modern methods (against the 13,350,000 tons produced in 1959), the iron target 27,500,000 tons (against 20,500,000 in 1959), and that for coal 425,000,000 tons (347,800,000 tons in 1959). The vast natural resources of the country are partly shown in estimates which put the iron-ore reserves at 12,000,000,000 tons and coal reserves at 1,000,000,000,000 tons.

In India plans are going ahead for the laying of 720 miles of pipeline designed to carry some 2,705,000 tons of crude oil a year from upper Assam down to the plains. It will feed two new state-owned refineries, one at Noomati on the Brahmaputra River in Assam and the other at Barauni in the state of Bihar. To extract the oil the Indian Government in partnership with the Burmah Oil Co. set up a new company—Oil India Private, Ltd. India, it is announced, aims to produce about 6,500,000 tons of steel by the end of the 1961–1966 third five-year plan, when the expansion programme of the three steel plants located at Bhilai (Madhya Pradesh), Roukela (Orissa), and Durgapur (West Bengal) will be completed. A fourth plant to be set up under the third plan at Bokaro (Bihar) will have a production capacity of 1,000,000 tons a year.

In Pakistan the Minister of Fuel, Power, and Natural Resources has said that the Government is to undertake an extensive geological survey to prepare detailed plans for exploitation of mineral resources. He said the largest allocation of foreign exchange in the import budget had been made for purchase of the necessary equipment. The United Nations Special Fund was assisting Pakistan in explorations. The Government had also decided to include in the survey Azad Kashmir and tribal areas where oil prospecting would also be done. A scheme was finalized to raise the production of chromite from 18,000 tons to 50,000 tons annually by 1964, all of which is exported.

A Japanese steel mission to Delhi has signed an agreement with the Indian Government for the yearly supply to Japan of 4,000,000 tons of iron ore from the Bailadila ore project in the Bastar district, Madhya Pradesh. It is arranged that the agreement, for a period of 15 years, will start from the middle of 1966 when the Bastar project will have been developed.

Following the International Tin Council's decision to lift export controls from October 1, 1960, more mines opened in Malaya and tin production consequently increased. At the same time increased demand from Japan continued to spur the iron-ore output.

Russia and Indonesia have signed an agreement for the setting up of an atomic research reactor and an iron and steel mill in Indonesia with Russian assistance. It was also agreed that Russia would provide long-term credits to Indonesia amounting to U.S.$250,000,000 for industrial development. About 30 Russian mining experts arrived in Jakarta to conduct a survey of the country's mineral and power resources.

Dr. F. H. Fitch, Director of the Geological Survey Department, British Territories in Borneo, said in Jesselton that there had never before been such widespread activity in mineral prospecting as there was towards the end of 1960 in North Borneo.

A Japanese mining and engineering team completed a survey of bauxite deposits in West Borneo and submitted a report to the Indonesian Government.

A mission which was sent to the Philippines by the Federation of West German Industries reported that a survey of the Philippines' mineral resources was essential.

February 16.

Malaya.—Malaya produced a record total of 5,500,000 tons of iron ore—valued at more than (Malayan) $140,000,000—last year. Production has increased progressively year by year recently, the outlook depending upon Japan, the main purchaser. Royalties to Malaya's five producing states—Trengganu, Perak, Johore, Kelantan, and Kedah—were estimated to total about $14,000,000 in 1960. Some 6,500 people were employed at the 24 iron mines, 13 of which are in the Ipoh area of Perak, which has become an important iron-ore producing area second only to Trengganu.

A United Nations iron and steel survey mission arrived in Singapore recently to advise the Government on whether proposals to set up an iron and steel mill are feasible.

India.—The total value of India's mineral production increased by about 10% during the first half of the last year, as compared with the corresponding period of 1959. The total value for the first six months of 1960 is given as more than Rs. 770,000,000 against Rs. 700,000,000. The increase was mainly the result of higher outputs of coal, iron ore, chromite, bauxite, dolomite, and limestone and the higher price of gold bullion.

The Rajhara iron-ore mines have now been fully mechanized by the joint Indo-Russian venture to ensure an adequate supply of ore to the Bhilai steel plant. The mines, situated about 55 miles south of Bhilai and linked by the South Eastern Railway, will now feed the steel plant with about 7,000 tons of iron ore daily. Deposits at Rajhara are estimated at about 15,000,000 tons, having an iron content ranging from 65% to 69%.

The second blast-furnace of the Durgapur steel plant in India has been put into commission. It has the same capacity as the first furnace—1,250 metric tons a day.

Pakistan.—The Pakistan Government has announced its decision to set up a steel mill in Karachi. The feasibility report submitted by the British consultants, John Miles and Partners, is to be put up to a few reputable firms on the Continent and the United Kingdom, the United States, and Japan.

SOUTHERN AFRICA

February 26.

Union Economy.—In the three years 1960, 1959, and 1958, imports into South Africa were respectively valued at £555,627,000, £488,659,000, and £555,510,000; for the same years exports were respectively valued at £437,578,000, £428,598,000, and £391,407,000, excluding gold sales. Over the three years exports are seen to have increased steadily, with some rounding off evident in 1960. The more erratic pattern of imports over the period reflects in part general economic conditions. The current year has seen the re-imposition of the tighter import control policy of 1959. This arises from the inroads into the reserves last year of the substantial increase in imports, but more particularly from the drain on reserves caused by the outflow of capital, on uncertainties over the political trends, in both the country itself and to the north. The adverse trade balance in the three years was respectively £118,049,000, £60,061,000, and £164,103,000. While the respective gold sales of £286,669,000, £242,147,000, and £221,869,000 more than covered the respective adverse trade balances, they have not on balance also covered the outflow of capital, especially in 1960.

All branches of Treasury receipts, and particularly in the Inland Revenue Account and in the Customs and Excise Account, have been reflecting clearly better returns than in the 1959–60 year. With heavy tax receipts again expected in the closing two months of the 1960–61, and Customs and Excise returns expected at least to maintain income, the year ending March 31 should reflect another substantial surplus. Expenditure or issues on revenue account have apparently been kept well in hand and to the end of January conformed closely to the estimates for the year. The main problems that seem to confront the Government in framing its Budgetary proposals are those associated with the political front. Consequently, it would appear that fiscal proposals are hardly the weapons with which those main problems can or will be opposed. Such problems as are associated with the political front are obviously being left in the hands of the Prime Minister during his visit to London. On the other hand, the Budget proposals are not expected to be such as to add to the Prime Minister's task overseas. Few real basic changes are, therefore, expected in the forthcoming Budget proposals, which can be expected to expand public purchasing power

wherever possible without detracting much from savings ; and to encourage domestic investment and industrial development. Increasing tax and lease payments from gold operations should offset or counter-balance the anticipated decline in revenue from uranium production. Any relief from the now progressively heavier gold payments may, therefore, well take the form of incentives to establish new mines rather than lighten the burden on the younger producers to any appreciable extent. Any surplus at the end of March will be matched, without doubt, by a commensurate transfer to the loan account, where the pressure will still be felt, in view of the continued difficulty in raising capital funds for external expenditure. The Finance Minister recently indicated that there was no immediate intention of interfering with the current Bank rate and implied that the occasion did not call for monetary measures to reverse the outflow of capital funds. Such measures, in any event, would be costly. Where the outflow results from high imports, reliance is being placed on import control as the logical and obvious redress. On balance, the Minister is hardly confronted this year with inflationary conditions. The tone of the Budget, if not all the contents, should therefore, be expansionary.

General.—Mechanical equipment for one berth at Port Elizabeth has been ordered as part of the delayed programme of expanding ore-loading facilities at the port, in which it has for some time been deficient. The plant, capable of handling about 1,500 tons an hour, will be commissioned in 1963 and will consist of truck tipplers, stockpiling conveyors, and loading conveyors leading to and housed in a gallery 600 ft. long and parallel to the ship's berth.

The Witwatersrand Native Labour Association of the Chamber of Mines has received from the Tanganyika authorities six months' notice to suspend the recruiting of native labour for the gold mines. The agreement provided for the recruiting of a maximum of 10,000 a year, which is equivalent to about 1 in 37 of the total native complement. The real effect of the cancellation is not expected to be very marked and is regarded as more political a gesture than one forming the first towards forcible restraint on the movement of migratory labour.

Diamonds.—In the national interest the Government has decided that all future prospecting for and exploitation of diamond deposits in unalienated State-owned land in the Namaqualand area, Northwestern Cape, will be conducted by a State-controlled corporation, specifically established for this purpose. All future applications for rights to exploit such land by private interests or individuals will not be considered. Earlier the Government had announced that companies would be formed, apparently under State auspices, to co-ordinate the operations of private interests and individuals who had applied for prospecting rights in the area, in which companies' applicants would have been represented and would have had shareholdings of some sort. The number of applicants had seemed to be relatively small. However, it had been found that the applicants represented a much larger number of interested parties than was actually known and further applications had been received from other applicants. In the aggregate, therefore, the interests and aims of the applicants were found to be of such a divergent nature as to be incapable of being co-ordinated within the framework of the proposed companies. The project of the companies was, therefore, set aside in favour of the State-controlled corporation.

Gold Production.—Mainly as the result of continued expansion of operations by the young or new gold mines and their higher mill ore grade, and more generally of the improved native labour complement, the industry's output and overall revenue reached a new peak in 1960. Provisional returns put output from all sources at about 21,386,000 fine oz., against corresponding 1959 and 1958 figures of 20,064,000 oz. and 17,666,000 oz. Uranium oxide production again contributed massively to the industry's aggregate revenue, but the contractual nature of sales at stabilized levels provided no fresh additions to the increase in revenue. Output of uranium oxide in 1960 amounted to 6,409 short tons, against 6,444 tons in 1959 and 6,246 tons in 1958. In the aggregate the combined revenue, including gold and uranium oxide, of the major producers rose to £316,351,000 in 1960, from £298,261,000 in 1959, and £267,795,000 in 1958.

Uranium.—In its recent official statement on the new uranium agreements under which South African producers will operate over the next 10 years the Chamber of Mines explained that the old contracts had been drawn up when demand for uranium oxide was heavy and prices for South African output were made very favourable, relative to prices paid elsewhere for new production. The South African prices were based on incentive-type formulae (related to costs), which, however, made it difficult for the Combined Development Agency (representing the United States and the United Kingdom) to assess their ultimate commitments with any certainty. More recently demand has fallen off considerably and the United Kingdom has

deferred its nuclear power programme. Furthermore, there have been discoveries of new large deposits of uranium mineral. In the circumstances prevailing the high prices paid to South African producers have been embarrassing to the U.S. Atomic Energy Commission. Moreover both representatives in the Agency, while fully prepared to honour their contracts in their tonnage commitments, became more and more determined to end the rising prices being paid to South African producers, resulting from the escalator clause as applied to the steady increase in average South African mining costs. They desired a fixed price, while the United Kingdom desired to defer part of their contractual purchases to the second half of the 1961–70 decade. The position obviously called for give-and-take. Some high-cost producers found stretching out output and spreading out income over the decade unattractive and the new arrangements had to provide for this. For the low-cost producers—including some of the younger mines—closure of plants in the middle of the decade might mean possible loss of some business on an immediate basis and limitations on re-entry into the more future markets. Between the two extremes of high- and low-cost producers were others who were prepared to transfer their sales quotas on a royalty basis to low-cost mines, without detriment to their anticipated income. Finally, there had to be considered the State to whom deferment of foreign exchange when reserves were falling was of serious concern. Under the new arrangements producers selling prices have been fixed at relatively equitable levels in individual cases and there will be 17 mines supplying 13 extraction plants in the 1961–63 period, while 11 plants in 1964–65 will be operating, eight in 1966, and six mines in 1967–70 will be supplying five plants. From 1966–70 the major uranium producers will be West Rand Consolidated, Buffelsfontein, the joint Western Reefs-Vaal Reefs project, Hartebeestfontein, and Harmony. In the case of Dominion Reefs mining operations will be suspended at the mid-year and thereafter the plant will be kept at capacity operations treating accumulated uranium-bearing gold residue slimes to the end of 1963.

At Randfontein the new arrangements concluded will enable the mine to exploit its perhaps relatively limited resources of high-grade ore in the closing stages of its own production, while the progressive reduction in operational activity will facilitate a more rational and economical closure of the mine than maintaining full-scale operations to the date of closure. Gold production will be continued to the end of 1966 according to present plans, thereby extending the period in which a higher gold price might bring relief.

In the case of Buffelsfontein, a low-cost mine, the plant output capacity is about 500 tons of oxide a year, whereas its new sales quota amounts to an annual average of 230·5 tons. The mine was favourably placed to purchase quota rights, which will bring in average revenue of about 80·05s. a lb., against which average royalties payable will be 49·44s. a lb.

In the case of West Rand Consolidated the rights purchased at a royalty of 59s. will bring in revenue of 85·67s. a lb. This mine will probably be the only primary uranium producer in production in 1970, the new arrangements reached facilitating this and the prospect that the mine will be in a competitive position to meet world market conditions at that time.

Rights purchased by Blyvooruitzicht will enable the mine to keep its plant operating at full capacity during the stated period of production, while in the case of Harmony full plant operation will be maintained until the end of 1965, but thereafter to 1970 output rates will be reduced to about half the capacity rates.

In the case of the high-cost joint scheme embracing Presidents Brand and Steyn, Welkom, Loraine, and Freddies Consolidated, the two plants will be placed on a caretaking basis in the immediate future for later re-commissioning should circumstances warrant that.

Instead of operating separately the projects at Western Reefs and Vaal Reefs will be converted to a joint scheme under which the uranium-bearing pulp from Vaal Reefs will be piped to the plant of the former mine and the Vaal Reefs plant closed down. Rights bought by the joint scheme will be subject to royalty payments of 51·33s. a lb., reduced to 51s. in 1964 and 1965. At Hartebeestfontein the average price receivable from the total production given will be 71·84s. a lb., while it will pay royalties of 50·24s. on the rights purchased by it. The new arrangements will enable the mine, a low-cost producer, to compete for any new uranium business offering in future years.

Transvaal.—The Palabora Mining Co., Ltd.—formed some years ago by the Newmont Mining Corporation, Rio Tinto, and other interests to prospect an extensive relatively low-grade copper deposit at Phalaborwa in the North-eastern Transvaal—has now advanced operations to the stage at which pilot-plant tests of the ore are to be conducted, pending the possible initiation of full-scale operations. The final decision on extension will, it is understood, be taken when the pilot test runs have been

completed. It was stated in 1957 that the estimated cost of bringing the project to full-scale production will be in the neighbourhood of £25,000,000. The copper deposit—considered to be mainly malachite and azurite—occurs in the property of the Phosphate Development Corporation and extends beyond it. It would appear that the company has been assured that mining rights will be granted to permit the initiation of full-scale operations.

Negotiations are proceeding for the manufacture in the Union of atomized ferro-silicon for use in heavy-media separation or beneficiation plants. This process of separation or beneficiation is locally mainly applied to diamond recovery and ore benefication processes. The world patent rights for the manufacture of atomized ferro-silicon are held by Knapsack-Griesheim A.G., of Germany. Successful negotiations will confer on African Metals Corporation, Ltd., domestic rights of production.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Pipe Laying by Helicopter

Earlier in the year a helicopter was used for laying steel pipe for the first time in this country. Half a mile of 8-in. nominal bore pipe made up of 100 flange lengths of 20 ft. and each weighing 4 cwt. was laid across Cliff Marshes, near Gravesend, by a British United Airways Widgeon machine. The job was completed in 8 hours' flying time; by normal methods it might have required ten days to a fortnight. The helicopter was fitted with slings designed by **G. Hunter (London), Ltd.,** of Greenley Road, Grays, Essex, by whom these notes and illustrations have been provided.

Aircraft for Geophysical Survey

Described as the first fixed-wing aircraft to carry an in-and-out-of-phase electromagnetometer for commercial contract surveys, the Explorer 1 Canso mounts the most complete array of exploration instruments. Its first use will be a detailed follow-up survey of a

Widgeon Helicopter Laying Pipe.

Explorer 1 Canso Aircraft for Survey Work.

60,000 square mile air reconnaissance of Surinam, after which it will return for surveys in Canada. Explorer 2 is now being made ready for winter surveys.

The aircraft carries four geophysical units: (1) The Canadian Aero EM system, a high sensitivity in-and-out-of-phase unit previously available only for helicopters. (2) The Gulf Mark III magnetometer as used in nearly 15 years of Canadian exploration. (3) A sensitive scintillation counter for locating radioactive minerals. (4) The AFMag electromagnetic detector, developed in Toronto by Stanley Ward and others. In addition the aircraft is equipped with Doppler radar for surveys over jungle and other undifferentiated terrain, while over terrain with recognizable landmarks its Aeropath continuous-strip camera records the flight path.

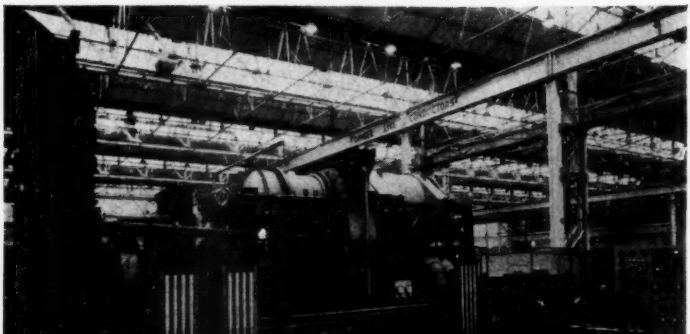
Tests show the fixed-wing installation can conduct surveys over remote areas at low cost. The Explorer 1 has a range of 1,300 miles; its normal survey altitude is 150 ft. to 180 ft. above terrain; coil separation is 83 ft.; depth of penetration is up to 425 ft. sub-aircraft and its sensitivity is up to 20 to 25 parts per million.

These notes and the illustration are made available by **Canadian Aero Service, Ltd.,** of Ottawa.

Industrial Gas Turbine

The first of four gas turbines building at the Hucclecote works of **Hawker Siddeley Brush Turbines, Ltd.,** for the new trans-Syrian pipeline of the Iraq Petroleum Co. has, it is reported, passed its acceptance tests at the manufacturer's works. These tests included seven hours' continuous load running, four hours of which corresponded to the maximum site rating of 6,600 b.h.p. and were completed in less than three days after the first trial run. The gas turbines, as illustrated, are built under licence from the **Clark Bros. Co.,** of New York, and are available for powers up to 9,300 h.p. They are, it is stated, designed to have high reliability under the arduous conditions of pipeline pumping and, for this reason, operate with a maximum gas temperature which is very moderate by gas turbine standards. These turbines are the first of this type to be built in this country.

Gas Turbine in course of Erection.



Personal

G. B. BATTY is to retire as senior consulting engineer of Gold Fields of South Africa, Ltd.

K. J. CARTER is now manager of Wittenoon (Asbestos) Mines, W.A.

E. S. EVERITT, managing director of Ruston-Bucyrus, Ltd., and a director of Bucyrus-Erie Company of South Milwaukee, U.S.A., has been appointed a director of Ruston and Hornsby (Australia), Pty, Ltd.

A. F. FAULKNER has been appointed a director of South Crofty, Ltd.

M. L. FITZGERALD has been appointed a director of Rio Tinto Management Services (Aust.) Pty., Ltd.

ALEXANDER GAKNER, an expert on the Soviet mineral economy, has resigned from the Federal Bureau of Mines in Washington to become assistant vice-president, International Division, Royer and Roger, Inc.

C. F. GEDDES has been appointed a director of the British Tin Investment Corporation, Ltd., and its subsidiary companies.

S. B. GIBBS, general manager of West Driefontein, has been appointed a consulting engineer and will be transferred to head office with effect from the beginning of April.

B. H. HOWELL is home from South Africa.

H. E. JENSEN has been appointed a director of Rio Tinto Management Services (Aust.) Pty., Ltd.

M. H. KROEN has joined the staff of Climax Molybdenum Company (Zurich), Switzerland.

T. G. MURDOCK has left Turkey for the United States.

JOHN W. SEMMENS has left for South Africa.

JOHN F. THOMPSON, honorary chairman of International Nickel, has been elected an honorary member of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

P. VISWANATHAN has joined the Ceylon Mineral Sands Corporation as chief chemist.

JUSTUS SJÖGREN, chairman of Sandvik Swedish Steels, Ltd., and Sandvik Steel Band Conveyors, Ltd., died on February 21, at the age of 82.

COMAR WILSON, associated with the Anglo American Corporation and the De Beers groups for more than 40 years, died on February 14, aged 57.

ARTHUR HUBERT COX, who died on February 14, aged 76, was Professor of Geology at Cardiff from 1918 until his retirement in 1949. A graduate of the University of Birmingham, his work on the strata of the South Wales coalfield is well known and he also contributed much to the study of geophysical methods in surveying deep structures. He served as a member of the Iron Ore Committee in 1918, the Geophysical Committee in 1929, and the Geological Survey Board in 1938 and just before his death had been awarded the Lyell Medal of the Geological Society of London.

Sir ARTHUR JOHN GRIFFITHS SMOUT, who died on February 21, at the age of 72, was educated at King Edward's School, Birmingham, and Birmingham Technical College. In 1905 he joined the Elliot group of metal companies, becoming works manager of Elliot's Metal Company, Ltd., in 1920 and from 1924 to 1934 production director to the Elliot Group, Ltd., later merged into Imperial Chemical Industries, Ltd. Sir Arthur became managing director in 1934 and was chairman from 1934 to 1942 of what is now the metals division of I.C.I. He was appointed to the main board of I.C.I. in 1944 with responsibility for the company's metal and ammunition interests. During the war he was Director-General of Small Arms Production, later becoming Director-General of Ammunition Production. Sir Arthur was a Fellow and former president of the Institute of Metals, a Fellow of both the Royal Institute of Chemistry and the Institution of Metallurgists, and was a vice-president of the Institution of Mining and Metallurgy. He was knighted in 1946.

Sir CHARLES CARLOW REID died on February 19, aged 82. A well-known coal mining engineer, he became during the war Regional Production Director for Scotland, under the Ministry of Fuel and Power, and in 1943 was appointed Director of Coal Production. In October, 1944, he was chosen by the Minister to preside over an expert committee to report on the technical changes required to bring the coal mining industry " to a state of full technical efficiency." What inevitably became known as the Reid Report was published in April, 1945. Appointed a member of the National Coal Board at its inception in 1948, he soon resigned, being unable to feel confidence in the methods for rationalizing production the Board adopted.

WILLIAM SELKIRK, well known to all mining men and intimately associated with the development of the Copperbelt of Northern Rhodesia, died on February 16, aged 92. Trained technically as an articled pupil with the late J. D. Kendal in the Cumberland Haematite mines, he later held various junior appointments in Mexico, Spain, the Gold Coast, the Ivory

Coast, and England, until he was appointed geologist in 1897 to an expedition to Central Africa to search for gold. After that he became manager to the Panuco Copper Mining Company, in Mexico, and from there he went as manager at the Mountain Copper Company's mines in California. He resigned that position in 1901 and returned to England to take up an appointment, which led to his commencing practice in London as a consulting mining engineer. He retired from private practice in 1925 and immediately joined Mr. (now Sir) Alfred Chester Beatty who had recently formed a company called Selection Trust, which early explored the area which became the Roan Antelope mine. Selection Trust also formed other companies, of all of which Mr. Selkirk became a director, until his retirement at the end of 1945. He was a Fellow of the Imperial College of Science and Technology, a Member of the Institution of Mining and Metallurgy, a Fellow of the Geological Society, a Member of the American Institute of Mining and Metallurgical Engineers, and an Honorary Associate of the Royal School of Mines. A Hall of Residence at Imperial College, of which he was a generous benefactor, now bears his name.

Metal Markets

During February [1]

Copper.—Although subject to some fluctuation during the month February copper prices [2] were generally firmer than January's. The basic supply and demand relationship is still no different from that at the time of the announcement of major production cutbacks by certain North and South American interests in mid-January, the overall effect of which was discussed in last month's report, but dominating the market all through February was the threat of serious interruption to production and shipment of metal from the African continent. The Congo crisis, which has been a market factor ever since the attainment of independence last July, seemed at one time likely to come to a head in civil war following the death of Mr. Lumumba. If so there is little doubt that production from the mines in Katanga would have come to a halt or at least been severely curtailed. However, that was not the only threat that presented itself, another equally serious being that of a strike of European mineworkers in Rhodesia in support of the stand taken by Sir Roy Welensky and the Federal Government over the proposed new constitution for Northern Rhodesia. That in itself was bad enough, but when the constitutional talks broke down in deadlock and both African and European sides in the dispute declared themselves in opposition to the final compromise constitution imposed by the British Government there were considerable doubts about the future maintenance of law and order in Rhodesia.

It is not surprising, therefore, that prices showed new strength. In any other circumstances but those of considerable oversupply, which are such a feature of the copper scene at the time, that strength would certainly have been more marked than it was, but the fundamental situation is still bearish and at the very end of the month when there were signs of some relaxation of the Rhodesian tension prices began to slip back noticeably.

Seldom does a month go by nowadays without some scare over production prospects and no doubt there will continue to be such scares in the coming months. No matter how serious or often such scares may be, however, the only real chance of better prices for any sustained period continues to lie in increased consumption. For that, as emphasized last month, one must still look mainly to the United States where offtake has been disappointing ever since the end of the major strikes at the beginning of 1960.

United Kingdom copper consumption in December amounted to 56,279 tons, of which 43,311 tons were refined. United Kingdom output of primary refined copper in December totalled 10,844 tons, while that of secondary refined was 8,567 tons. End-December stocks of refined copper rose to 96,700 tons from 93,880 tons at the end of November. Blister stocks, however, fell to 17,752 tons, as compared with 21,425 tons the month before.

Tin.—The threat of civil war in the Congo, which occupied so much of the headlines at one stage during the month, had repercussions on the tin market in much the same way as it did on copper. Unlike copper, however, tin is not in abundant supply at the present time and with this fact in mind it is not surprising to find that the price rise stimulated by precautionary consumer buying of tin was much more marked and that prices [1] were well maintained even after the threat of civil war had lessened considerably in the second part of the month.

However, the fact that the worst of the crisis came at the time the Singapore market was closed for two days for the Chinese New Year holiday also tended to make the rise of prices

[1] Recent prices, pp. 136, 176.
[2] See Table, p. 176.

[1] See Table, p. 176.

on the London market more pronounced than it might otherwise have been, because it diverted buying interest to London which would normally have been seen in Singapore.

Nevertheless the basic position is bullish and if it needed to be underlined at all the extent of the rise in Singapore values in the first few days after trading was resumed there should have effectively demonstrated the true state of affairs. In the face of all that happened on the market during February, however, it must be pointed out that consumer demand other than that induced by the Congo situation is still not particularly marked. There have been signs of some re-awakening of United States interest, it is true, and all the talk at the present time is of a pick-up in activity in the tinplate industry, not only on the other side of the Atlantic but here in the U.K. as well, now that canners are reaching the stage when they must put in their orders for the summer season, but so far little of this has been seen in increased tin purchases. When they do come, as surely they must, prices could well show further rises.

U.K. December tin consumption amounted to 1,588 tons and production in the same month amounted to 2,396 tons. These compare with November figures of 2,164 tons and 2,408 tons respectively. Stocks at the end of the year in this country showed a further increase at 11,778 tons compared with 11,366 tons at the end of November.

Lead.—Lead prices [1] improved quite handsomely considering the sort of levels that have ruled since the New Year, in the middle part of February, but latterly they have again been depressed. New consumer buying was again generally lacking and it is because of this that prices continue to fail to show any real strength. The only reason, in fact, that they did improve at all was because the values ruling at the beginning of the month finally tended to discourage producers on the Continent from offering in any quantity on the London market. The result—as so often in the past—was that, reflecting the new state of affairs, prices slowly edged upwards. However—again as so often in the past—when the net improvement was several pounds per ton (in this case almost £3) Continental producers were tempted back into the market.

It has happened before and it will no doubt happen again, but what was particularly interesting about the latest influx of Continental lead was that some of it—if not the main quantity—was of Soviet origin. Before now the Soviet authorities have offered zinc from time to time but never lead. However, not many months ago they registered lead on the London Metal Exchange for the first time and observers are now wondering whether Soviet lead sales are likely to become a regular feature of the market in future.

In the past Russian lead output has been below requirements, although zinc production has been considerably in excess of consumption. Last year, however, while Soviet-bloc zinc output was estimated at still some 50,000 tons more than was needed, it is believed lead production just about equalled requirements. It could well be that now it, too, is overtaking consumption, in which case the chances of regular sales on the world market in future are considerably enhanced.

U.K. lead consumption in December totalled 30,148 tons, while production of English refined lead in the same month was 6,793 tons. Stocks at the end of December amounted to 70,853 tons, as compared with 64,341 tons (revised) at the end of November.

Zinc.—Lead prices improved in February because there was a falling off in offerings from the Continent. A similar reduction in offerings (this time from the United States) lead to an improvement in zinc values. Unlike the lead market, however, the zinc market [1] was not subject to any renewal of offerings towards the end of the month and the chances are that in so far as the recent depression has been due to a surfeit of U.S. exports brought about by the still sluggish state of the American domestic market it is now largely a thing of the past; not that the United States market has shown much sign yet of improving since President Kennedy took office in January and it has generally been conceded that such an improvement is what is really needed to solve the present problems. The fact is that a number of U.S. zinc producers have recently taken a new look at the situation and come to the conclusion that while waiting for a pick-up in demand they must take some positive action themselves. In consequence several of them have announced reductions in output and sales over the next few months which (if nothing else) should serve to reduce the present surplus if not to cut it out altogether.

Without any surplus production there can be none of the substantial export shipments which were such a feature of the closing months of last year and the first month of this and the world market is likely to be much healthier. In fact the present situation is not so very different from that in the summer months of last year when

[1] See Table, p. 176.

[1] See Table, p. 176.

the sacrifices made earlier by certain producers in the Commonwealth and elsewhere brought about a period when supplies and consumption were just about evenly balanced. The only difference at the present time is that offtake is not proceeding at the same high rate as it was last summer.

December zinc consumption in the United Kingdom totalled 28,481 tons while output amounted to 8,565 tons. End-December zinc stocks stood at 59,397 tons, as compared with only 52,659 tons at the end of November.

Iron and Steel.—A more cautionary tone has settled upon the U.K. steel market. While ingot outputs have been maintained at an impressive level and a number of mills continue to work at around capacity limits reports from the various steelmaking areas indicate that consumers are hesitant about the outlook for the second half of the year. Last year the shortage of many products forced consumers to order material far ahead but supplies are now much easier; another influencing factor at the present time is that large stocks of steel are held by users.

The news of some improvement in the motor-car industry is naturally welcomed by the steel industry, but although the wide strip mills are expected to be able to raise outputs (which were curtailed a month or so ago) it is thought that the motor trade's big stocks of sheets might have a depressing effect upon new orders for some little time. The better trend in car sales is a result of the Government's decision to ease hire-purchase restrictions and does not stem from any appreciable rise in the export sales which must be secured to remove anxieties over this important industry.

Plate and section mills are working at top pressure and current order loads are thought to be satisfactory. There is, however, considerable concern over the future of one of the heavy steel industry's big customers, the shipyards. Substantial tonnages of steel are still being despatched to shipbuilders, but there are no signs of any improvement in the placing of new contracts and more idle yards are in prospect.

The shortage of semi-finished steel has been overcome and re-rolling mills will not now have to rely upon supplementary supplies from the Continent and elsewhere. The bar and rod mills are still very busy and consumers are still ready to take up material. Export business in iron and steel is at a fair level, but very competitive conditions prevail in the world steel export market.

Iron Ore.—Blast-furnaces in the U.K. continue to operate at an impressive level and consumption of iron ore naturally remains high. The iron-ore import trade is normally quiet at this time of the year owing to the freeze-up of ports in Canada, a leading supplier. Arrivals in the first month of the year reached 1,429,626 tons, as compared with 1,353,093 tons in January a year ago.

Aluminium.—The big news of the month with regard to aluminium was the confirmation of Aluminium Limited's withdrawal from the Volta Aluminium consortium (Valco). It had been half expected for some time—in fact ever since the end of November when Limited's president, Mr. N. V. Davis, issued his warning against expanding aluminium production too far ahead of demand (a warning which has since been echoed by the chiefs of several other companies in the Alcan group, the latest being Nippon Light Metals), but the official word only came in the latter half of February. When it did it did not come from the company but by way of the draft agreement between Valco and the Ghana Government published in Accra. From all reports the official reason was given as "the development of a new process" by which, it seems, is meant the Gross process, developed in this country and now due to undergo large-scale trials at a plant being constructed specially for the purpose at Aluminium Limited's site at Arvida. The company has neither confirmed nor denied it, but it is generally conceded that this will yield aluminium direct from bauxite without it first having to be converted to alumina as at present. Just how the successful development of such a process will be likely to affect Aluminium Limited's activities with more traditional means of production, however, is not easy to see at the present time.

Despite Mr. Davis's fears of a glut of aluminium in the next few years, however (he said in November that existing schemes alone could well result in supplies to the world outside the Communist bloc being ahead of requirements to the extent of 1,500,000 tons by the end of 1965), other groups continue to talk of new schemes. One of the latest is a plan by Reynolds Metals of the United States and the Turkish Government for a $25,000,000 aluminium industry in Turkey based initially on imported bauxite with the substantial domestic reserves to be used later. Other projects in the news in February include a plan for a new 60,000-ton plant in Mysore State which, it is reported, will be the biggest in India so far.

Antimony.—New developments in the antimony market in February were singularly lacking after the events of recent months and prices of English antimony regulus, delivered,

held steady throughout at £210 and £217 10s. per ton respectively for 99% and 99·6% material. The British Bureau of Non-Ferrous Metal Statistics has now issued final figures for 1960 consumption. Total U.K. usage of new metal at 5,719 tons was 796 tons up on the 1959 figure. The biggest quantity again went into the manufacture of antimony oxides (2,655 tons), but after that the biggest single quantity (2,506 tons) was accounted for by increased consumption of antimonial lead for new and replacement motor-vehicle batteries. In fact the increase in the amount so used accounted for some 90% of the increase in total antimony consumption.

Arsenic.—February was yet another featureless month for the arsenic market, with prices unchanged once more at £400 per ton for the metal and £40 to £45 per ton for the trioxide.

Bismuth.—Bismuth continued to sell during February at a nominal 16s. per lb. for ton lots, ex warehouse.

Cobalt.—The price of cobalt has not changed since March, 1960. Throughout February the open-market quotation was again 12s. per lb. United Kingdom contract material was again quoted at 10s. 9d. per lb., while the black and grey oxides were once more offered at 7s. 10d. and 8s. 4d. per lb., respectively.

Cadmium.—Cadmium quotations were unchanged in February at 11s. per lb. for U.K. and Empire metal 99·9% and 10s. 9d. to 11s. per lb. delivered, duty paid, for foreign. Both prices apply to 1-cwt. lots.

United Kingdom cadmium consumption in 1960 as reported by the British Bureau of Non-Ferrous Metal Statistics rose 130 tons above that of 1959 and of this increase 74 tons was directly attributable to increased requirements for cadmium colours. The total consumption figures for 1959 and 1960 respectively were 1,257 tons and 1,338 tons.

Chromium.—There were no new developments in the chromium metal market in February and prices were again unchanged throughout at 6s. 11d. to 7s. 4d. per lb.

Tantalum.—The tantalite market was again steady in February with prices maintained throughout at 1,000s. to 1,200s. per unit for material assaying 60% Ta_2O_5.

Platinum.—There were no new developments in platinum in February. Day-to-day interest throughout the month in both Commonwealth and open-market (Russian) metal was at much the same desultory levels as for some months past and prices per troy ounce were again £30 5s. and £27 10s. to £28 15s. respectively.

A new method of assessing platinum production costs has been adopted at Rustenburg Platinum Mines. Hitherto it has been based on the cost of production offset by a notional value of £1 per oz. in the case of other platinum-group metals produced and £1 per ton in the case of copper and nickel. Based on the total cost of producing all metals, less the revenue received from the sale of by-product metals, the new method has resulted in a fall in the book cost per oz. of producing platinum. Since the new method was made known there has been some conjecture as to whether it will have any bearing on future selling prices.

Iridium.—Iridium sponge and powder prices were unchanged at £20 to £26 15s. per troy oz. in February.

Palladium.—Interest in palladium in February was again very limited and prices showed no change throughout the month from the £8 10s. to £9 7s. 6d. per troy oz. quoted for some time past.

Osmium.—Osmium quotations were again unchanged throughout the month at £17 to £25 per troy oz.

Tellurium.—Tellurium lump and powder was again quoted at 28s. 6d. per lb. in February. The price of tellurium sticks (minimum 99·5% purity) was also unchanged from the previous month at 40s. per lb.

Tungsten.—Only moderate tonnages of tungsten ore were bought in February, most consumers preferring to wait until they needed material before committing themselves. Consequently market sentiment was generally weak and the fact that several deals were conducted in low-priced Russian ore tended to pull down quotations until by the end of the month the published range stood at 126s. to 131s.

Nickel.—With nickel still priced at £600 per ton, a figure which has held good for some years now, some surprise was expressed among observers in February at news from the United States that the International Nickel Co. might soon be the subject of a Senate Anti-Trust Sub-Committee investigation. Apparently several U.S. steel producers have complained that the company is profiteering through "devious speculations" involving nickel sales to the U.S. Government for stockpiling purposes while it buys material from the stockpile and resells it to smaller steel producers at enhanced prices.

Chrome Ore.—While hopes for any worthwhile pick-up in consumer inquiry for chrome ore continue to rest mainly on the possibility of increased activity in the U.S. steel industry later this year, Turkish exporters have been trying to increase their share of any business

that might be going by reducing their prices. Officially Turkish material is still quoted at $33·50 per ton f.o.b., the minimum export price fixed some time ago by the Turkish Etibank. However, exporters are in fact now understood to be indicating $31·50 per ton as and when they receive any inquiry.

Nevertheless, the chance of any marked switch of buying to Turkey still seems remote to judge by the figures given last month by Japanese ferro-chrome producers for the sort of prices they have been asked for Rhodesian and Indian ores. Rhodesian metallurgical 49% is said to have been offered at $29 (£10 7s. 6d.) per ton f.o.b. and Indian 50% ore at $28·50 (£10 10s.). It remains to be seen whether Philippine ore will be reduced as the Japanese ferro-chrome producers hope. Meanwhile the official quotation for Rhodesian metallurgical ore is again unchanged at £15 5s. per ton c.i.f.

Molybdenum.—There have been no really new developments in the molybdenite market recently other than a certain tightening in the supply situation in February which had largely eased off again by the end of the month. Prices remained throughout at 8s. 11d. per lb. Mo contained f.o.b. mine for material obtained from Climax and 9s. 3½d. per lb. c.i.f. for other ore.

Manganese Ore.—February was another uneventful month as far as manganese-ore trading was concerned and prices are still indicated at 68d. to 71d. per unit of metal contained c.i.f. Europe. Hopes of more American manganese-ore buying this year on the open market have been dampened somewhat by estimates of 1960 ore imports published in February. According to these U.S. imports were up some 150,000 tons as compared with 1959 despite the disappointing level of purchases generally. The answer lies in the fact that certain U.S. steel interests now have their own ore sources in Brazil, which means that their calls on the open market are still likely to be reduced even when activity in the U.S. steel industry is more pronounced than it has been in the last few months. At the same time other U.S. interests are working on the development of further manganese-ore sources elsewhere in South America, which will also reduce American buying on the outside market at some future stage.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Feb. 10	787 0	790 10	220 17½	222 17½	64 18¾	66 3¾	82 12½	81 12½
13	787 10	790 15	223 7½	224 17½	65 8¾	66 11¼	83 16¼	82 16¼
14	790 10	793 15	223 2½	224 7½	65 17½	66 17½	83 17½	82 17½
15	791 10	794 15	224 2½	225 7½	66 7½	67 7½	83 16¼	83 1¼
16	793 10	796 5	224 7½	225 5	66 12½	67 8¾	84 7½	83 11¼
17	794 10	796 15	223 15	224 12½	66 17½	67 11¼	84 2½	83 3¾
20	797 10	799 15	226 5	226 7½	66 17½	67 8¾	84 2½	83 7½
21	797 10	799 15	226 12½	226 12½	66 18¾	67 11¼	84 12½	83 13¾
22	802 0	803 15	227 17½	227 17½	66 11¼	67 6¼	84 17½	83 13¾
23	801 10	804 0	227 12½	227 12½	64 3¾	65 6¼	84 2½	83 2½
24	803 0	804 15	229 2½	228 17½	64 12½	65 12½	84 13¼	83 6¼
27	805 0	805 15	230 10	230 7½	65 7½	66 1¼	84 11¼	83 6¼
28	801 0	802 5	227 7½	227 7½	64 10	65 6¼	84 2½	82 18¾
Mar. 1	802 10	803 5	226 2½	226 7½	64 16¼	64 16¼	83 17½	82 17½
2	801 0	803 5	225 15	226 7½	63 12½	64 16¼	83 8¾	82 6¼
3	803 10	805 5	226 7½	227 7½	64 11¼	65 7½	84 1¼	82 13¾
6	804 0	806 15	225 7½	227 2½	64 17½	65 16¼	84 2½	82 17½
7	804 10	807 5	226 2½	227 12½	65 6¼	66 6¼	85 3¾	83 16¼
8	807 0	810 10	226 7½	227 7½	65 18¾	66 18¾	85 2½	83 13¾
9	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	January		February	
	Treated Tons	Yield Oz.†	Treated Tons	Yield Oz.*
Blyvooruitzicht	135,000	87,610	127,000	82,391
Brakpan	146,000	17,760	137,000	17,000
Buffelsfontein‡	148,000	61,190	148,000	65,419
City Deep	119,000	24,268	105,000	21,990
Cons. Main Reef	45,000	10,207	46,000	9,765
Crown Mines	189,000	32,819	177,000	30,876
Daggafontein	222,000	44,970	200,000	44,534
Dominion Reef	36,300	530	41,000	485
Doornfontein‡	110,000	45,914	110,000	46,206
D'rb'n Roodeport Deep	192,000	34,943	177,000	32,701
East Champ D'Or‡	12,000	322	12,000	275
East Daggafontein	108,000	18,360	104,500	17,870
East Geduld	125,000	35,938	125,000	35,938
East Rand P.M.	236,000	51,616	224,000	49,491
Eastern Transvaal Consol	19,800	5,978	18,500	5,910
Ellaton‡	26,000	5,939	25,000	5,859
Freddies Consol	61,000	13,048	59,000	13,047
Free State Geduld	95,000	82,621	95,000	83,173
Free State Saaiplaas	50,000	11,491	50,000	11,696
Geduld	80,000	13,005	75,000	12,001
Government G.M. Areas‡	52,000	9,534	44,000	9,187
Grootvlei Proprietary	215,000	44,507	210,000	43,472
Harmony Gold Mining	177,000	71,886	172,000	70,036
Hartebeestfontein‡	130,000	60,450	126,000	58,275
Libanon	117,000	28,167	117,000	28,498
Loraine	82,000	19,475	81,000	20,055
Luipaards Vlei‡	114,000	13,060	110,000	13,125
Marievale Consolidated	99,000	24,106	92,000	22,402
Modderfontein East	58,000	6,670	54,000	6,109
New Kleinfontein	74,000	10,059	70,000	9,566
New Kierksdorp‡	10,600	1,359	10,200	1,380
President Brand	118,500	93,616	118,000	93,227
President Steyn	106,000	39,628	106,000	39,712
Rand Leases	181,000	25,068	176,000	24,024
Randfontein‡	164,000	9,635	152,000	10,401
Rietfontein Consolid't'd.	12,000	3,184	12,000	3,240
Robinson Deep	43,000	9,879	39,000	9,358
Rose Deep	25,000	4,290	21,000	3,958
St. Helena Gold Mines	178,000	61,859	170,000	59,935
Simmer and Jack	70,000	12,848	70,000	12,448
S. African Land and Ex.	101,000	20,959	102,500	20,827
S. Roodepoort M.R.	30,000	7,262	26,000	6,431
Spaarwater Gold	11,100	3,548	10,900	3,633
Springs	94,000	12,823	90,500	12,584
Stilfontein Gold Mining‡	171,000	77,506	171,000	78,300
Sub Nigel	66,500	15,032	64,000	14,723
Transvaal G.M. Estates	—	—	—	—
Vaal Reefs‡	103,000	47,896	100,000	46,501
Van Dyk Consolidated	73,000	11,411	70,000	11,372
Venterspost Gold	114,000	32,712	117,000	34,041
Village Main Reef	31,500	4,174	31,500	4,095
Virginia O.F.S.‡	132,000	27,647	123,000	26,420
Vlakfontein	52,000	18,811	50,000	18,546
Vogelstruisbult‡	83,000	17,604	79,000	17,001
Welkom Gold Mining	97,000	30,091	95,000	29,847
West Driefontein‡	130,000	121,582	130,000	121,577
West Rand Consol.‡	206,000	20,723	199,000	19,665
Western Holdings	159,000	109,282	160,000	110,001
Western Reefs	139,000	40,310	140,000	40,601
Winkelhaak	95,000	32,301	90,000	30,826
Witwatersrand Nigel	20,000	4,290	19,400	4,204

† 253s. 3d. * 250s. 7d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Dec., 1959	17,670,000	72 2	45 10	26 4	30,559,937
Jan., 1960	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,464,400	72 8	46 5	26 3	30,105,571
April	—	—	—	—	—
May	—	—	—	—	—
June	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept	18,103,100	74 0	46 4	27 8	32,201,685
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,272,800	76 2	47 0	29 2	33,039,583

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
February, 1960	1,675,248	38,859	1,714,107
March	1,664,514	38,744	1,703,258
April	1,734,310	36,720	1,771,030
May	1,765,889	37,897	1,803,777
June	1,775,335	37,530	1,812,865
July	1,776,141	39,673	1,815,814
August	1,778,711	36,777	1,815,488
September	1,774,967	35,352	1,810,319
October	1,777,495	35,967	1,813,462
November	1,775,624	36,159	1,811,783
December	1,744,406	34,044	1,778,450
January, 1961	1,785,614	34,407	1,820,021

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
May 31, 1960	383,212	30,933	414,145
June 30	380,593	31,435	412,028
July 31	378,626	31,879	410,505
August 31	374,303	32,321	406,624
September 30	369,751	32,996	402,747
October 31	368,391	33,387	401,778
November 30	367,658	33,052	400,710
December 31	364,407	32,791	397,198
January 31, 1961	384,816	33,513	418,329

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Feb. 11		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	10,800	1,742	1,753
Electrolytic Zinc	16,059	771	4,658
Lake George	—	—	—
Mount Isa Mines**	—	—	—
New Broken Hill	38,930	4,448	8,917
North Broken Hill	26,501	5,189	5,730
Zinc Corp.	40,500	5,780	6,951
Rhodesia Broken Hill*	—	—	—

* 3 Months, ** Copper 3,470 tons blister; 6,439 tons concs.; † Metal

RHODESIAN GOLD OUTPUTS

	January		February	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	22,500	4,305	—	—
Globe and Phœnix	—	—	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	3,009	—	2,628	—
Coronation Syndicate	12,466	—	11,802	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	January		February	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	46,494	10,778	30,257	9,318
Ariston Gold Mines	36,500	11,325	35,000	10,837
Ashanti Goldfields	38,000	30,000	—	—
Bibiani	27,295	5,625	26,000	5,690
Bremang	—	3,611	—	—
Ghana Main Reef	12,110	4,377	10,881	4,403
Konongo	7,200	3,750	7,220	3,680
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1959		1960	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	46,489	18,077	44,902	29,711
February	43,366	19,806	45,754	29,865
March	48,397	17,394	45,309	29,656
April	46,315	5,694	48,607	6,847
May	46,423	46,280	47,542	62,912
June	49,995	31,386	45,884	34,298
July	46,512	32,734	44,865	33,323
August	38,727	29,178	48,284	28,931
September	56,760	33,837	48,865	38,951
October	48,528	32,314	47,473	37,308
November	47,916	31,092	46,439	33,896
December	47,452	31,175	—	—

WESTRALIAN GOLD PRODUCTION

	1959	1960	1961
	Oz.	Oz.	Oz.
January	63,924	64,794	62,434
February	65,035	66,789	—
March	65,408	61,941	—
April	62,686	65,373	—
May	64,184	66,682	—
June	74,590	74,902	—
July	78,974	67,623	—
August	68,546	67,466	—
September	66,501	68,794	—
October	70,427	67,310	—
November	68,858	107,815	—
December	117,474	76,269	—
Total	861,122	855,758	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Jan. 3		To Jan. 31	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,083	8,239	13,981	8,048
Gold Mines of Kalgoorlie	40,336	11,655	35,178	12,217
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	29,754	4,689	31,985	4,519
Lake View and Star*	180,968	41,375	—	—
North Kalgurli	29,428	7,470	28,501	7,469
Sons of Gwalia	15,301	3,581	18,594	3,922
Mount Morgan	—	3,115	—	3,515

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
September, 1959	754,208	213,772	34,139	7,116,556
October	794,080	227,192	34,733	7,558,567
November	770,437	227,176	35,262	7,600,949
December	775,803	221,377	40,807	7,388,654
January, 1960	778,103	226,856	27,617	7,550,068
February	755,569	222,484	35,003	7,446,848
March	804,309	229,457	37,202	7,646,044
April	779,487	218,393	42,997	7,426,262
May	784,391	225,550	32,174	7,765,153
June	791,488	223,833	49,765	7,756,490
July	779,426	222,179	37,002	7,664,968
August	712,792	202,025	35,722	6,883,254
September	772,984	208,019	29,251	7,114,785
October	805,753	228,914	33,808	7,860,787
November	785,133	230,377	31,149	7,917,352
December	783,501	229,639	37,560	8,020,961

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	January		February	
	Tons	Oz.	Tons	Oz.
Clutha River	—	657	—	697
Lampa (Peru)†	—	29,256	—	34,060
New Guinea Goldfields	4,001	841	—	—
Yukon Consol.	—	—	—	—

† Oz. Silver : Copper, 141 tons ; 110 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1959	246,693	89,162	305,163
Provisional			
1959—January	12,946	7,744	14,874
February	23,658	8,493	26,361
March	27,377	9,776	30,402
April	82,992	8,142	23,477
May	25,122	9,400	26,832
June	27,786	10,087	29,298
July	17,570	10,351	19,861
August	25,115	9,757	26,247
September	28,671	9,088	29,333
October	28,923	8,701	28,133
November	—	—	—
December	—	—	—

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Dec.	Jan.	Feb.
Ampat Tin	75	70	33
Austral Amalgamated	600*	—	—
Ayer Hitam	637*	—	—
Berjuntai	215	247	216½
Chenderiang	74*	—	—
Gopeng Consolidated	652*	—	—
Hong Fatt (Sungei Besi)	129½*	—	—
Hongkong Tin	48*	—	—
Idris Hydraulic	114½*	—	—
Ipoh	3*	13	18
Kampong Lanjut	257	190½	92
Kamunting	122	116	107½
Kent (F.M.S.)	85*	—	—
Kepong	95*	—	—
Killinghall	112*	—	—
Kinta Kellas	23	15½	16
Kramat	46	45½	48
Kuala Kampar	140	143	137
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Larut	32	39	19
Lower Perak	35	58	120
Malayan	656*	—	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	630*	—	—
Pengkalen	158*	—	—
Petaling Tin	417*	—	—
Rahman Hydraulic	—	—	—
Rambutan	82*	—	—
Rantau	66	63	52½
Renong	188*	—	—
Selayang	4½*	—	—
Siamese Tin Syndicate (Malaya)	43	57	44
Southern Kinta	309½	345	343
Southern Malayan	1,141*	—	—
Southern Tronoh	12*	—	—
Sungei Besi	408*	—	—
Sungei Kinta	—	—	—
Sungei Way	314*	—	—
Taiping Consolidated	230*	—	—
Tanjong	—	—	—
Tekka	—	—	—
Temoh	291*	—	—
Tongkah Harbour	128	153	117
Tronoh	714*	—	—

* 3 Months.

NIGERIAN MINE OUTPUTS (TONS)

	Nov.	Dec.
Cassiterite	885	924
Columbite	199	200
Felspar	—	—
Gold*	65	69
Kaolin	—	2
Lead Ore	—	15
Limestone	18,524	30,302
Monazite	1	1
Tantalite	18	18
Thorite	—	1
Wolfram	—	—
Zinc	—	—
Zircon	179	158

* Oz.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Jan.		Feb.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines..	358	51	376	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	47	—	41	—
Beralt	3	175†	3	175†
Bisichi	62	32½	—	—
Ex-Lands Nigeria	—	—	45	—
Fabulosa	51	—	—	—
Geevor	58	—	—	—
Gold and Base Metal	70	5	—	—
Jantar Nigeria	18½	29	—	—
Jos Tin	10	—	—	—
Kaduna Prospectors	5	—	6½	—
Kaduna Syndicate	21	—	21	—
Katu Tin	39	—	8	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	8½	—	—	—
Naraguta Tin	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	94	—	86	—
South Bukeru	—	—	—	—
South Crofty	82	—	74	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	20	1	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

November, 1960.

Gold	1,809,698 oz.
Silver	188,611 oz.
Diamonds	311,174 carats *
Coal	3,542,466 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 3,303 tons of 98·84%.
Tin	238 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	14,746 tons.
Chrome Ore	69,567 tons.
Manganese Ore	119,978 tons.
Lead Concs.	28 tons.

* *October, 1960.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Dec.	Jan.
Iron Ore	tons	1,305,600	1,429,626
Manganese Ore	„	68,046	55,703
Iron and Steel	„	115,738	84,928
Iron Pyrites	„	28,631	24,910
Copper Metal	„	39,277	50,151
Tin Ore	„	5,336	2,140
Tin Metal	„	220	376
Lead	„	21,811	18,252
Zinc Ore and Conc.	„	7,513	27,274
Zinc	„	17,062	17,172
Tungsten Ores	„	432	770
Chrome Ore	„	12,552	16,047
Bauxite	„	29,906	49,925
Antimony Ore and Concs.	„	1,281	1,295
Titanium Ore	„	11,071	37,002
Zirconium Ores and Concs	„	—	2,726
Tantalite/Columbite	„	11	96
Sulphur	„	36,076	47,239
Barytes	„	4,453	3,628
Asbestos	„	18,595	14,177
Magnesite	„	6,541	14,753
Mica	„	573	622
Graphite	„	811	631
Mineral Phosphates	„	118,100	115,908
Molybdenum Ore	„	998	587
Silicon	„	445	662
Nickel	cwt.	71,381	81,760
Aluminium	„	446,906	594,517
Mercury	lb.	313,024	180,567
Bismuth	„	75,037	132,567
Cadmium	„	158,352	255,700
Cobalt and Cobalt Alloys	„	254,968	167,306
Selenium	„	32,257	18,339
Petroleum Crude	„	942,077	1,218,466

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	104	0	0
„ „ 80% Technical	„	90	0	0
Alum, Comml.	„	25	0	0
Aluminium Sulphate	„	16	5	0
Ammonia, Anhydrous	per lb.		1	6
Ammonium Carbonate	per ton	59	0	0
„ Chloride, 98%	„	28	12	6
„ Nitrate	„	36	5	0
Antimony Sulphide, golden	per lb.		4	4
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98–99%	„	42	0	0
„ Chloride	„	45	0	0
Barytes (Bleached)	„	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	„	46	10	0
Boric Acid, Comml.	„	77	10	0
Calcium Carbide	„	40	17	9
„ Chloride, solid, 70/75%	„	13	5	0
Carbolic Acid, crystals	per lb.		1	3
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2⅞
Citric Acid	per cwt.	9	17	0
Copper Sulphate	per ton	75	15	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	„		7	10
Hydrochloric Acid 28° Tw.	per carboy		13	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iodine	per kilo		17	4
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	„	112	5	0
„ Nitrate	„	110	0	0
„ Oxide, Litharge	„	101	5	0
„ Red	„	99	5	0
Lime Acetate, brown	„	40	0	0
Lithopone	„	57	10	0
Magnesite, Calcined	„	20	0	0
„ Raw	„	13	0	0
Magnesium Chloride	„	20	0	0
„ Sulphate, Comml.	„	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	1
Nickel Sulphate	per ton	180	0	0
Nitric Acid, 80° Tw.	„	35	0	0
Oxalic Acid	„	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	„		1	2½
„ Bromide	„		2	6
„ Carbonate (hydrated)	per ton	72	10	0
„ Chloride	„	21	0	0
„ Iodide	per kilo		19	3
„ Hydrate (Caustic) solid	per ton	92	0	0
„ Nitrate	per cwt.	3	10	0
„ Permanganate	per ton	198	0	0
„ Sulphate, 50%	„	21	1	0
Sodium Acetate	„	63	0	0
„ Arsenate, 58–60%	„	Nominal		
„ Bicarbonate	„	18	10	0
„ Bichromate	per lb.		1	0
„ Carbonate (Soda Ash) 58%	„	16	0	0
„ Chlorate	„	77	10	0
„ Cyanide	per cwt.	6	18	10
„ Hydrate, 76/77%, solid	per ton	33	0	0
„ Hyposulphite, Comml.	„	35	0	0
„ Nitrate, Comml.	„	Nominal		
„ Phosphate (Dibasic)	„	40	10	0
„ Prussiate	per lb.		1	0½
„ Silicate	per ton	11	10	0
„ Sulphate (Glauber's Salt)	„	12	5	0
„ „ (Salt-Cake)	„	10	0	0
„ Sulphide, flakes, 60/62%	„	38	12	6
„ Sulphite, Comml.	„	27	15	0
Sulphur, American, Rock (Truckload)	„	13	0	0
„ Ground, Crude	„	17	10	0
Sulphuric Acid, 168° Tw.	„	12	0	0
„ „ free from Arsenic, 140° Tw.	„	8	10	0
Superphosphate of Lime, 18% P_2O_5	„	13	15	0
Tin Oxide	„	Nominal		
Titanium Oxide, Rutile	„	172	0	0
„ White, 25%	„	85	0	0
Zinc Chloride	„	95	0	0
„ Dust, 95/97% (4-ton lots)	„	125	0	0
„ Oxide	„	95	0	0
„ Sulphate	„	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Feb. 8, 1961 £ s. d.	Mar. 8, 1961 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 12 6	2 15 0
Blyvooruitzicht (2s. 6d.)	1 7 6	1 8 0
Bracken (10s.)	1 8 6	1 8 6
Brakpan (3d.)	4 3	4 0
Buffelsfontein (10s.)	2 0 6	2 0 6
City Deep	18 9	16 6
Consolidated Main Reef	13 6	13 0
Crown Mines (10s.)	1 7 0	1 3 6
Daggafontein (5s.)	1 1 9	1 1 3
Dominion Reefs (5s.)	1 1 0	1 1 0
Doornfontein (10s.)	1 8 0	1 9 3
Durban Roodepoort Deep (10s.)	1 12 3	1 8 3
East Champ d'Or (2s. 6d.)	1 6	1 9
East Daggafontein (10s.)	9 9	8 6
East Geduld (4s.)	19 3	18 3
East Rand Ext. (5s.)	18 0	17 6
East Rand Proprietary (10s.)	1 14 9	1 11 3
Freddies Consol.	2 0	1 9
Free State Dev. (5s.)	6 0	5 3
Free State Geduld (5s.)	5 10 6	5 10 6
Free State Saaiplaas (10s.)	8 0	8 0
Geduld	2 12 6	2 12 6
Government Gold Mining Areas (3d.)	2 9	2 6
Grootvlei (5s.)	19 3	1 0 0
Harmony (5s.)	1 7 6	1 8 0
Hartebeestfontein (10s.)	2 10 0	2 10 6
Libanon (10s.)	14 9	14 3
Loraine (10s.)	1 7 6	1 7 6
Luipaards Vlei (2s.)	7 9	8 6
Marievale (10s.)	1 6 6	1 8 3
Modderfontein B (3d.)	1 6	1 6
Modderfontein East	11 3	10 6
New Kleinfontein	5 3	4 0
New Pioneer (5s.)	1 12 9	1 10 3
New State Areas (15s. 6d.)	9	9
President Brand (5s.)	2 19 3	2 17 6
President Steyn (5s.)	18 9	19 9
Rand Leases (9s. 3d.)	6 9	5 9
Randfontein	1 1 9	1 1 6
Rietfontein (3d.)	2 9	2 6
Robinson Deep (5s. 6d.)	5 0	4 6
Rose Deep (3d.)	6 0	6 0
St. Helena (10s.)	3 12 3	3 8 9
Simmer and Jack (1s. 6d.)	1 6	1 6
South African Land (3s. 6d.)	16 9	15 3
Springs (3d.)	1 3	1 3
Stilfontein (5s.)	1 13 6	1 13 0
Sub Nigel (3d.)	9 3	8 9
Vaal Reefs (5s.)	2 1 6	2 2 0
Van Dyk (3d.)	2 9	2 3
Venterspost (10s.)	19 9	1 0 6
Virginia (5s.)	3 9	3 6
Vlakfontein (10s.)	16 3	17 3
Vogelstruisbult (3d.)	5 0	5 0
Welkom (5s.)	17 3	17 0
West Driefontein (10s.)	4 13 6	4 11 9
West Rand Consolidated (10s.)	18 0	17 6
West Witwatersrand Areas (2s. 6d.)	3 7 9	3 5 3
Western Holdings (5s.)	7 3 9	6 16 3
Western Reefs (5s.)	1 7 6	1 7 3
Winkelhaak (10s.)	1 5 6	1 6 0
Witwatersrand Nigel (2s. 6d.)	1 0	1 0
Zandpan (10s.)	12 3	11 6
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	15 0	13 9
Coronation (2s. 6d.)	5 0	4 9
Falcon (5s.)	9 6	8 9
Globe and Phœnix (5s.)	1 15 0	1 12 6
Motapa (5s.)	—	—
GHANA:		
Amalgamated Banket (3s.)	9	9
Ariston Gold (3s. 6d.)	3 9	3 9
Ashanti Goldfields (4s.)	15 0	13 3
Bibiani (4s.)	3 9	3 9
Bremang Gold Dredging (5s.)	3 6	3 6
Ghana Main Reef (5s.)	2 9	2 9
Konongo (2s.)	1 3	1 0
Kwahu (2s.)	5 3	4 9
Offin River (2s. 6d.)	2 3	2 0
Western Selection (5s.)	5 0	4 6
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 6	1 6
Gold Mines of Kalgoorlie (10s.)	8 0	8 0
Great Boulder Propriet'y (2s.), W.A.	12 3	12 6
Lake View and Star (4s.), W.A.	1 5 0	1 5 6
Mount Morgan (10s.), Q.	14 3	12 9
New Guinea Gold (4s. 3d.)	1 6	1 3
North Kalgurli (1912) (2s.), W.A.	10 6	9 9
Sons of Gwalia (10s.), W.A.	2 9	2 9
Western Mining (5s.), W.A.	10 3	9 9

	Feb. 8, 1961 £ s. d.	Mar. 8, 1961 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 10 0	1 6 3
Kentan Gold Areas	1 0 0	19 9
St. John d'el Rey, Brazil	4 15 0	5 10 0
Yukon Consolidated ($1)	4 0	4 0
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	15 3	13 9
Esperanza (2s. 6d.), Cyprus	1 3	1 3
Indian (2s.)	5 3	5 3
MTD (Mangula) (5s.)	8 0	7 0
Messina (5s.), Transvaal	17 3	16 0
Mount Lyell (5s.), Tasmania	4 9	5 0
Nchanga Consolidated, N. Rhodesia	2 7 9	2 4 3
Rhokana Corporation, N. Rhodesia	2 6 0	2 2 0
Roan Antelope (5s.), N. Rhodesia	6 0	5 3
Tanganyika Concessions (10s.)	1 8 6	1 5 3
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	9 0	8 9
Burma Mines (3s. 6d.)	1 3	1 0
Consol. Zinc Corp. Ord.	3 9 0	3 9 6
Lake George (5s.), N.S.W.	5 9	5 9
Mount Isa, Queensland (5s. Aust.)	2 7 3	2 6 3
New Broken Hill (5s.), N.S.W.	2 1 6	2 2 0
North Broken Hill (10s.), N.S.W.	15 6	14 6
Rhodesia Broken Hill (5s.)	7 3	6 6
San Francisco (10s.), Mexico	16 3	15 3
TIN:		
Amalgamated Tin (5s.), Nigeria	10 3	10 0
Ampat (4s.), Malaya	12 0	12 9
Ayer Hitam (5s.), Malaya	1 4 0	1 9 9
Beralt (5s.), Portugal	1 9 0	1 8 9
Bisichi (2s. 6d.), Nigeria	5 3	5 9
Ex-Lands (2s.), Nigeria	3 3	3 6
Geevor (5s.), Cornwall	18 6	1 1 0
Gold Base Metals (2s. 6d.), Nigeria	2 0	1 9
Hongkong (5s.), Malaya	10 9	12 9
Jantar Nigeria (3s.)	5 9	5 6
Kaduna Syndicate (2s.), Nigeria	2 6	2 3
Kamunting (5s.), Malaya	15 6	17 0
Malayan Tin Dredging (5s.)	1 5 6	1 6 6
Mawchi Mines (4s.), Burma	1 3	1 3
Naraguta Karama (5s.), Nigeria	1 6	1 3
Pahang (5s), Malaya	10 9	11 6
Siamese Synd. (5s.)	14 9	15 6
South Crofty (5s.), Cornwall	4 0	4 0
Southern Kinta (5s.), Malaya	1 10 9	1 9 3
Southern Malayan (5s.)	1 3 6	1 6 9
Sungei Besi (4s.), Malaya	1 6 6	1 8 9
Sungei Kinta, Malaya	17 0	18 0
Sungei Way (2s. 4d.), Malaya	4 3	4 9
Temoh (7s. 6d.), Malaya	4 6	4 6
Tronoh (5s.), Malaya	1 18 0	2 4 0
United Tin Areas (2s. 6d.), Nigeria	2 0	1 4½
DIAMONDS:		
Anglo American Investment	12 15 0	11 15 0
Consol African Selection Trust (5s.)	16 6	14 6
Consolidated of S.W.A. Pref. (10s.)	10 0	10 0
De Beers Deferred (5s.)	7 15 9	7 10 6
FINANCE, Etc.		
African & European (10s.)	3 5 0	3 5 0
Anglo American Corporation (10s.)	7 16 3	7 8 9
Anglo Transvaal 'A' (5s.)	1 16 6	1 13 6
British South Africa (15s.)	3 12 9	3 7 9
British Tin Investment (10s.)	1 13 6	1 17 6
Broken Hill Proprietary	2 10 0	2 12 9
Camp Bird (10s.)	7 3	7 3
Central Mining	3 14 3	3 6 6
Central Provinces Manganese (10s.)	1 4 3	1 5 6
Consolidated Gold Fields	3 0 6	2 19 3
Consolidated Mines Selection (10s.)	1 11 0	1 8 0
Corner House	16 3	16 0
East Rand Consolidated (5s.)	2 0	1 9
Free State Development (5s.)	6 0	5 3
General Exploration O.F.S. (2s. 6d.)	3 9	4 3
General Mining and Finance	5 0 0	5 7 3
Hendersons (4s.)	9 3	8 6
Johannesburg Consolidated	2 12 9	2 9 0
London & Rhod. M. & L. (5s.)	4 6	4 0
London Tin Corporation (4s.)	14 0	14 6
Lydenburg Est. (5s.)	14 6	12 0
Marsman Investments (10s.)	2 9	2 7½
National Mining	2 0	2 0
Rand Mines (5s.)	4 3 9	3 17 6
Rand Selection (5s.)	2 10 0	2 6 6
Rhodesian Anglo American (10s.)	3 0 6	2 12 9
Rhodesian Corporation (5s.)	2 6	2 3
Rhodesian Selection Trust (5s.)	9 6	8 6
Rio Tinto (10s.)	1 19 3	1 17 3
Selection Trust (10s.)	4 6 9	4 0 0
South West Africa Co. (3s. 4d.)	10 0	10 0
Union Corporation (2s. 6d.)	3 0 6	2 16 9
Vereeniging	5 11 6	5 6 3
West Rand Inv. Trust (10s.)	2 15 0	2 13 9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Copper Smelter in Southern Rhodesia

A description of the copper smelter erected at Alaska siding in the Lomagundi district of Southern Rhodesia to process concentrates from the Mangula and Alaska mines is given in the Rhodesian *Chamber of Mines Journal* for January. The plant, described as of conventional design, has a total installed h.p. of approximately 4,000, which includes a 1·5 MW turbo-alternator.

Separate outside storage bunkers are provided for incoming fluxing materials, those used being iron pyrites, dolomite, and silica. These are fed from the bunkers to a hopper by the transporter and from there to a vibrating feeder into a 20 in. by 12 in. jaw-crusher. The 3-in. product is then conveyed to a 2-ft. cone-crusher and the *minus* ½ in. crushed material is transported by belt to the storage bins provided for the different products.

Two sizes of coal are also stockpiled, the larger portion being duff, the other nut coal. During wet weather the nut coal is fed to a three-stage roll crusher *via* a vibrating feeder. During fair weather duff coal is fed to the coal storage bin, the coal passing straight through the roll crusher. All coal fed to the storage bin is weighed continuously by means of load cells fitted to a weighing section in the conveyor.

The coal is fed from the storage bin by means of a tubular vibrating feeder to a 6 ft. by 8 ft. dry grinding ball-mill of conventional design. The mill is driven by a 150-h.p. squirrel-cage motor and started by means of an auto-transformer starter. This is made possible by incorporating a power coupling between the motor and V-belt pulley. Pulverized coal is air-classified in a single horizontal classifier where the oversize is returned to the mill and the undersize, 85% to 90% *minus* 200 mesh, is discharged through collecting cyclones to the storage bins. The whole system is sealed by adjustable counterweighted check valves.

The concentrate storage building provides storage and removal facilities for concentrates received from Mangula and Alaska. Those stored in bulk are fed to the reverberatory furnace by means of a tractor shovel *via* portable 24-in. conveyors feeding the main conveyor-belt. A predetermined amount of iron pyrites and dolomite is added by vibrating feeders to the concentrates on the belt as it passes under the flux bins on the way to the reverberatory furnace charge hoppers.

The reverberatory furnace charge hoppers are arranged in a row above and along each side of the furnace and the concentrates, mixed with the requisite amount of fluxes, are added to the furnace by a slide gate assembly which is attached to the hopper. The furnace is normally charged every two hours.

The furnace, 24 ft. wide by 80 ft. long, is fired with pulverized coal through four 15-in. burners, two 12-in. side burners being for heating up the settling zone when required. Pulverized coal used in the reverberatory furnace is drawn from the storage bins by variable-speed screw conveyors feeding into a venturi through which the primary air passes, conveying the coal along a pipe to the burners.

The normal liquid bath depth is about 28 in. from the centre of the tap-holes with 20 in. of matte. As the long axis of the furnace is parallel to the converter aisle the matte is tapped into 90-cu. ft. ladles as and when required by the converters. Slag can be skimmed from both sides of the furnace. Molten converter slag is returned to the furnace by means of ladles through a cast-steel launder situated in the side-wall near the firing end. The matte grade is about 58% to 60% copper.

Flue gases from the reverberatory furnace are drawn through two parallel 8-ft. by 6-ft. flues to the stack by two induced-draught fans. In the one flue a waste-heat type boiler is installed; this is rated at 19,000 lb. steam per hour at 380 lb. per sq. in. and a superheat temperature

of 700° F. The boiler is followed by a tube-type pre-heater supplying preheated secondary air for the burners at 450° F. The induced-draught fan in this flue has a capacity of 40,000 c.f.m. The other flue, by-passing the boiler, is equipped with a 150,000 c.f.m. induced-draught fan. Fluctuations in steam demand automatically control the volume of gases passing through each flue.

The converter aisle crane serving the furnaces is a 40-ton 500 V d.c. unit normally controlled by radio. The crane operator carries the transmitter on his back and operates all motions by push-button while standing on ground level. The equipment has a range of approximately 300 ft. and operates at a frequency of 162·8 megacycles. The main advantage of this type of control is that the operator can position himself to the best advantage for each operation.

The converter aisle is 224 ft. long and 53 ft. wide and accommodates two Pierce-Smith type converters, one 10 ft. by 15 ft. and the other 9 ft. by 18 ft. Each converter is equipped with 22 ball-valve tuyères spaced at 6-in. centres. The converters have burned magnesite-brick linings and are driven by 25 h.p. motors directly connected by means of intermediate gears to a heavy pinion engaging a large gear bolted to one of the riding rings. An emergency system using a flywheel drive is available in case of failure.

During normal operation the flywheel maintains full speed as it is working in parallel with the conventional drives. Only in case of emergency, such as power or air failures, will the flywheel take over and then only when the converters are in the blowing position.

Converter air is supplied by one 10,000 c.f.m. turbo-blower located in the power plant. Air is delivered at the converters at a normal pressure of 12 lb. to 13 lb. per sq. in.

The converter mouths are lined with a cast-steel collar. Converter hoods are of welded steel with cast-iron liners. A sliding apron which covers the hood while the converter is blowing is operated through an air cylinder.

Normally a converter is charged with two 90 cu. ft. ladles of matte which is fluxed with silica, blown, and skimmed; sufficient additional matte is added to make up a charge of approximately 20 tons of blister copper. The silica flux drawn from the storage bin situated at one end of the converter aisle is fed into the converter through an open-end steel container conveyed by the overhead crane.

The converter gases flow from the converter hood to a balloon type flue; thence to a dust-settling chamber from where they are channelled to a 300 ft. high brick chimney through which they are exhausted to atmosphere. The flue dust drops through pipes into cocopans and is returned to the smelting process by belt conveyors.

The plant for fire-refining is on the same level as the converter section. The equipment consists of one 65-ton capacity reverberatory-type refining furnace and a hand-operated type scrap charging machine. The refining furnace, which has a hearth dimension of 17 ft. by 10 ft., is constructed of silica and magnesite bricks held together by heavy buckstays and tie-rods. Cast-iron plates just inside the buckstays extend all around the furnace and form a backing for the furnace bottom and wall to the height of the metal line. The working bottom forms an inverted arch consisting of a bottom layer of 9 in. silica bricks and a top layer of 15 in. magnesite bricks. The side walls are built of magnesite bricks with a suspended 15-in. Chromag brick roof. The furnace is fired by pulverized coal, two burners being used. The gases from the furnace pass through the flue to a firebrick-lined steel stack 100 ft. high.

Molten blister copper is transferred from the converters to the refining furnace in 90 cu. ft. ladles. When a full charge has been received air pipes are put in and charge blown until a button sample shows a large block grain. When this point is reached the bath is skimmed clean and the poling operation started. Poling is carried out in the usual manner with green hardwood or gum poles and is continued until a block cast in a small cast-iron mould shows a fine-grained full set. The oxygen content of the refined copper at this point should be about 0·03% to 0·04%. A layer of low sulphur coke is added and casting may be started.

The Walker-type of casting wheel is 29½ ft. in diameter and holds 14 moulds. The operator's cab is positioned away from the wheel but directly in front of the pouring ladle. The casting aisle is 50 ft. wide and is spanned by a 5-ton overhead crane which serves the casting wheel, Bosch conveyor, and other equipment, as well as removing copper ingot bars which have been stacked by hand next to the inspection conveyor.

While casting is in progress the copper moulds are continuously cooled by water sprays from perforated pipes bent to the same radius as the mould circle. The moulds are turned and righted by means of fingers running on a guide rail. As the bars drop from the moulds they strike an inclined baffle plate submerged in water and slide on to the Bosch conveyor. Cooled bars drop from the top of the Bosch conveyor on to

an inclined steel apron which delivers them to an inspection conveyor on which they are gauged and inspected. The copper is then stacked, weighed, and placed on the copper platform ready for shipment. The reject bars and moulds are returned to the refining furnace.

The power plant consists of one 1·5 MW turbo-alternator, two electric boiler feed pumps, and the usual auxiliaries. In the same building are housed the 850 h.p. low-pressure blower and two 80-lb. per sq. in. compressors.

Power is generated at 3·3 kV and is stepped up to 11 kV. This supply is connected to the supply network and during low load periods power is fed back. Semi-automatic synchronizing equipment has been installed to eliminate any error when the machine is synchronized with the supply.

Water is pumped from several boreholes and during the dry season water can be pumped from Alaska mine situated 4 miles away. The water treatment plant consists of a softening plant, filter plant, and an ion exchange unit for further treatment of boiler feed water only. All domestic and cooling pond water is chlorinated.

Reverberatory furnace slag is hand-lashed to a tractor-drawn dumper and transported to the slag dumps. This will be replaced later by hydraulic end-tipping trucks hauled by a diesel engine.

Iron Ore in Ceylon

In an appendix to the "Administration Report of the Government Mineralogist for 1959"[1] there is a report by D. J. A. C. Hapuarachchi on "The Geological Structure of the Dela-Noragolla Iron-Ore Field, with Particular Reference to the Relation of Ore-Bodies to Structure." The author says that the mapping of the Dela-Noragolla-Nivitigala area was done on aerial photographs on the scale 4 in. to the mile. The area is dominated by the garnetiferous granulite, which is the iron-ore bearing formation. The other rock types in the area are charnockites, both intermediate and basic, quartzites, and also vein quartz. Structurally the area is folded, faulted, and jointed. The structure elements which form the pattern of structure are folds, fold axes, lineations, faults, and joints.

Structure.—The structure of the area is complex, nearly all the folds being normal structures with the exception of one or two which are overturned. There are two sets of folds in the area, one the axes trending in a north-westerly direction and the other at about 45° to this direction in a westerly direction. All the major folds and some of the minor folds in the area belong to the former set. Two sets of b-lineations confirm the occurrence of these two sets of folds. The first phase was the main phase of folding and is responsible for the major folds and associated minor folds. Subsequently the second phase took place and is responsible for the second set of folds. The gentle curves of fold axes which belong to the first set are most probably due to compressive forces which operated during the second phase. There are some minor folds which could hardly be mapped on this scale.

The folding is accompanied by faulting and jointing. Field criteria for the recognition of faults are sparse or absent and as such faulting cannot be readily recognized in the area, but when any available field evidence and other field data are combined with photo-geological data then faults become evident. Joints are numerous; most are tension or cross-joints.

In the northern half of the area west of the main road (Ratnapura-Kalawana) there are four major fold axes trending in a north-westerly direction and representing rather tightly-folded normal anticlines and synclines which plunge to the north-west. This is confirmed by the distinct b-lineations. The dip in this area varies from 20° to 85°, the jointing being well marked and most of the joints are cross-joints. There are three faults striking north–south approximately N. 20 E. and N. 25 W. The four major folds can be traced further south-east and in the southern half of the area they appear again with the difference that the normal syncline at the south-western end becomes overturned due to overturning towards the south-west of its south-western limb. It is not clear whether this axis is displaced or not. There is a linear structure extending south-westwards from the Dela factory for a distance of over 600 yd. but there is some doubt whether this is a fault or joint. The other folds remain normal structures and of course plunge in a north-westerly direction. The structure in this part of

[1] Government Press, Ceylon. Price –/95; postage –/20.

the area is further complicated by the occurrence of cross-folding resulting from the impinging of one set of folds on the other. One set of folds belongs to the main phase of folding and plunges in a north-westerly direction while the other set has a westerly plunge confirmed by the distinct b-lineations and arises from that phase of folding subsequent to the main phase. In the western extremity of this half of the area there is another anticlinal structure. The relation between this structure and the syncline further north-east is not clear for want of suitable exposures in the area. It seems probable that a fault intervenes between these two structures.

In the northern half of the area east of the main road there are two more folded structures. Owing to lack of suitable outcrops it is not possible to trace these structures north-westwards.

Relation of Ore-Bodies to Structure.—The occurrence of the iron-ore deposits is confined to the garnetiferous granulite which is thus referred to as the iron-ore-bearing formation. A study of the relation of ore-bodies to the structure in the area reveals that the ore-bodies occur within definite belts which are related to the structure. In other words, it would appear that the ore-deposits are not scattered indiscriminately in the garnetiferous granulite but occur within certain well-defined belts which can be recognized only on the basis of the structure pattern.

It seems unlikely that there is a relationship between the ore deposits and structural features such as faults and joints which commonly serve not only as channels for mineralizing solutions but also as loci of ore deposition. That is to say, these features do not appear to have had any control over ore location in the area because if they did then we would expect the ore-bodies to continue downwards to greater depths than they actually extend. Thus it seems that an appeal to mineralizing solution from depth to account for these ores seems an unlikely explanation as to their origin.

The iron-ore deposits occur in the form of lenticular bodies or small pockets and the ores are most probably of residual origin, derived probably from parts of the garnetiferous granulite richer in iron or from basic rocks of the charnockite group associated with the granulite or from both these sources. If the ore-bodies are considered in isolation to one another they would appear to have a random occurrence and bear no relation to the structure but when they are considered collectively their fields of occurrence appear to be restricted to certain areas which are shown by mapping to be recognizable belts which conform to the folding and thus have a definite orientation in the context of the structure pattern. These observations are based on the mapping of a well-defined belt of ore to which are all the major and minor deposits in the south of the area belong. The width of this belt is about 175 yd. Similarly the deposits occurring in the south of the area belong to another belt. Finally it may be concluded that if there are other deposits still unknown then the most likely locations for these ore-bodies are within the ore belts.

Alumina from Shale

An article by G. Thomas and T. R. Ingraham, both of the Extraction Metallurgy Division at the Mines Branch, Ottawa, on " The Development of the Alum-Amine Process for the Recovery of Alumina from Shale " appeared in the *Canadian Journal of Chemical Engineering* for December last. It has now been issued by the Mines Branch as Research Report R74.[1]

The authors point out that in attempts in Canada to decrease dependence upon foreign materials many attempts have been made to utilize the resources of clays and shales. None of the processes devised to date has succeeded in displacing the Bayer alumina process, but several have features which are of interest. At the Mines Branch of the Department of Mines and Technical Surveys various processes for producing alumina have been reviewed and some of the better features from several have been combined with liquid-liquid extraction techniques into an integrated process for the production of cell-grade alumina. The chemical feasibility of the scheme has been investigated on a laboratory scale by the treatment of a Canadian shale.

The experimental work was done on a typical shale from a large eastern Canadian deposit. The chemical analysis of the raw shale is: 58·2% SiO_2, 23·0% Al_2O_3, 6·1% Fe_2O_3, 3·5% K_2O, 1·7% MgO, 1·3% Na_2O, 1·3% C, 0·9% TiO_2, 0·8% CaO, 0·1% S, 0·09% P_2O_5, and the remainder L.O.I. Based on the mineralogical

[1] Ottawa: Mines Branch, Department of Mines and Technical Surveys. Price 25 cents.

and chemical analyses the estimated composition of the raw shale is as follows: Quartz, 35%; muscovite, 32%; clay minerals, 12%; chlorite, 11%; andalusite, 6%; magnetite, 2%; iron sulphides, 1%; and carbonaceous matter, 1%.

When the shale was baked with an equal weight of concentrated H_2SO_4 a sulphated product was obtained, which was leached with a small amount of 0·5% H_2SO_4 and then filtered, a hot concentrated leach liquor being obtained. On cooling the liquor a viscous crystalline mass of aluminium sulphate, with minor amounts of potassium alum, was obtained which was difficult to filter. Washing of this mass to remove the large amount of entrained iron-bearing mother liquor from the crystals was unsatisfactory. In contrast, by the addition of sufficient potassium sulphate to the hot concentrated leach liquor for the complete conversion of aluminium sulphate to potassium allum prior to cooling, well-defined, readily-filterable, octahedral crystals of potassium alum were formed which contained only 0·12% Fe. By recrystallizing and washing the impure crystals with equal weights of water potassium alum crystals containing 0·003% Fe were obtained. Calculations show that alum crystals of this purity would give, after decomposition and leaching, an alumina product that would meet cell-grade specifications for iron.

The feasibility of preparing alumina from alum has already been established. In a few experiments at the Mines Branch laboratories pure chemical-grade alum was dehydrated in an oven at 400° C. and, after pulverization of the fragile porous mass, the powder was decomposed at about 900° C. at a shallow bed depth of 0·5 cm. in a muffle furnace. In other tests alum was decomposed in a fluidizer, which consisted of a vertical 1 in. diameter silica tube, fitted at its base with a silica cloth for supporting the charge over the gas inlet. Alum was added slowly to the fluidizer at 900° C. for flash decomposition and brief fluidization. All calcines were then leached with water for the removal of potassium sulphate from the alumina. The results from these tests show that, under suitable conditions, the alum can be treated by decomposition and leaching to yield an alumina containing only small amounts of potassium—*e.g.*, 0·08–0·13% K.

Having prepared a suitable alumina from pure alum experiments were done to determine whether cell-grade alumina could be obtained from shale by the foregoing process. For this purpose three samples of sulphated shale, to which the requisite amount of potassium sulphate had been added, were leached at 95° C. with hot water. The hot filtered leach liquors were cooled and the resultant alum crystals were separated from the mother liquor by a basket centrifuge or by a sintered glass filter. The alum was recrystallized and washed several times for the removal of iron and the purified alum was decomposed at 900° C. By leaching the calcine with water for the removal of potassium sulphate an alumina product was obtained.

The purity of these alumina products compares favourably with Kalunite alumina from which commercially acceptable aluminium metal has been prepared. The impurity level is slightly in excess of that obtained by the Bayer process, but some improvement might be expected if specific precautions were taken to keep the impurity level low.

In cyclic tests about 94% of the soluble aluminium from the sulphated shale was recovered in the form of impure alum crystals. These alum crystals contained about 0·2% Fe. In subsequent cycles the accumulation of sulphuric acid from the hydrolysis of ferric sulphate gradually decreased the extent of hydrolysis so that the recycle mother liquor and the alum crystals contained increasing amounts of iron. However, by the addition of CaO to the leaching stage for neutralizing the acid, and thereby permitting continued hydrolysis of iron from the liquor, alum crystals of low iron content were again obtained. The impure alum crystals were purified by the use of equal weights of water in a 5-stage countercurrent crystallization circuit. A spectrographic analysis of products indicated the removal from the crude alum crystals of not only iron but also sodium, magnesium, calcium, titanium, and smaller amounts of other contaminants.

The purified alum crystals were dehydrated in silica trays at 400° C. and decomposed at 900° C. with the off-gases being vented to the atmosphere. The decomposed alum was leached at 95° C. and washed at 25° C. for the removal of potassium sulphate from the alumina. The cold wash solution was used in the crystallization circuit for the purification of crude alum. The hot leach solution from the leaching of decomposed alum, after cooling and filtering to remove K_2SO_4 crystals, was reheated and recycled for leaching additional K_2SO_4. The K_2SO_4 crystals were recycled to the head of the circuit to form alum. Additional experimental investigations are now in progress to determine whether large-scale pilot-plant work is warranted. Any final judgment as to the relative merits of this method of producing alumina will, the authors say, have to await an economic assessment based on pilot-plant data.

Training for Mine Management

A paper by Dr. G. F. Jacobs, group personnel officer to the Anglo American Corporation of South Africa, Ltd., on " Trends in Management Training " appears in the *Journal* of the South African Institute of Mining and Metallurgy for February. In the first part of his paper the author discusses the general problems, going on in his second part specifically to review conditions in the South African mining industry. Particularly does he refer to the fact that in South African law the manager of a registered mine must be the holder of a certificate of competency in mining, although in practice specific mining knowledge need only be demanded from the official who is in direct charge of the underground mining operations. Over the world, the author says, it is accepted that the higher the advance in the hierarchy of management the greater the emphasis and need for management knowledge as opposed to knowledge of the technical operations involved, so that any divisional head, provided he has sufficient managerial ability, should be able to rise to the position of general manager of the organization.

The mining industry, the author goes on to say, constitutes a peculiar type of industrial complex with its own particular structure and value concepts. It is not difficult to find explanations for this. To begin with mining is a hazardous type of occupation ; it contains a high risk element and all those who actively participate in production share a common danger. Its members therefore tend to close-in towards themselves. In terms of psycho-sociological phraseology they come to form an intra-centred community such as is also encountered in the army. Indeed the close similarity which exists between the mining and military groups, as manifested in organizational pattern, emphasis on status, etc., derives basically from this underlying factor.

The tendency towards " intra-centring," it is suggested, has many repercussions. It places emphasis on the familiar, the conventional, the traditional, and hence creates an atmosphere which induces resistance to change. It strives for maintenance and preservation of the central group and for safeguarding it from extraneous intrusions. It leads to identification of mining with " risk taking " and " production," a form of rationalization which is aimed basically at excluding from its inner ranks all those who are not intimately associated with the actual process of mining. It adopts an organizational tableau which places full emphasis on the line procedure, with the manager occupying a position at once autocratic and patriarchal, and it enshrouds itself in a value system which gives excessive prominence to status, earning capacity, and other materialistic considerations.

Success in mining is furthermore associated with quickness of response and decision-making. If there is a danger of a fall of hanging underground the individual must react immediately and there is no time to produce a slide-rule to calculate the theoretical stresses that the rock strata are being subjected to. This gives rise to an occupational pattern which places great emphasis on positiveness, decisiveness, and directness. Accordingly mining tends to produce men who are rapid " decision makers," but whose mental processes are often characterized by impulsiveness and primary functioning. That is why many tend to indulge in intuitive and subjective rather than objective thinking and prefer to concentrate on the immediate instead of the ultimate, the dynamics of management rather than its mechanics. As their natural reaction is an active rather than a passive one it tends to make them reluctant to become involved in detailed planning, particularly long-term planning. The general stereotype is that of the " doer " or " implementor " rather than the " thinker " or " visionary."

A further serious difficulty to be faced in the provision of management training in the mining industry is the shortage of trainers of appropriate calibre. It has been shown repeatedly that a purely technical training tends to narrow one's viewpoint and to be fully effective in management training fairly prolonged exposure to the broader academic disciplines such as is encountered in the field of the social humanities is required. As there is a dearth of individuals with this background the industry will either have to arrange for the special training of selected officials from its existing ranks or consider the importation of suitably qualified personnel from the outside.

These and other considerations complicate the task of management training in the mining industry, but there is much within the industry itself that is virile and dynamic. It has within its ranks some of the finest of human material and, with the new breath of enlightened management thinking which is prevalent today, the whole organizational pattern and background philosophy may well come to be revolutionized. As far as the more immediate steps in management training are concerned certain other features need to be emphasized.

South African universities, the author thinks, will have to be encouraged to develop a more comprehensive system of management training. It is probably fair to say that once it has been conclusively demonstrated that the demand exists the universities will take the further initiative. But although it can be assumed that the industry will in future draw a greater proportion of its managerial personnel from men who have had a university background, it will never be able to meet all its management needs from this source, and special training facilities for that large body of men who graduate from the ranks will have to be introduced immediately. This training must be comprehensive and must deal with the very foundations of the mechanics of management. It has been contended by some that TWI training supplies the answer to this problem, but this is not so. TWI training is not management training nor was it ever intended as such. Its value is strictly limited—because it touches on only the simplest of management problems—and the exposure period is too short to have any lasting value. Moreover, it serves as a sop to one's conscience and so provides line management with an excellent opportunity of escaping its real obligations and responsibilities for the management development of subordinates.

To have any lasting effects, it is concluded, management training will have to be far more fundamental in its approach and be aimed simultaneously at the three levels of management, top, middle, and first-line. To meet this need the following alternatives will have to be considered :—

(*a*) Basic management training, probably centred on the sandwich course system, should be introduced on the national plane for preference although it could, if necessary, be done on an industry basis.

(*b*) This training should preferably be full-time and be based on a system of live lectures and discussions. In America it has, however, been shown that management training can also be very effectively conducted through the correspondence medium. There is no reason why the mining industry should not take the initiative in this matter, supplementing these correspondence courses with live discussions organized on a regional basis.

(*c*) A knowledge of the theoretical principles of management must, however, be related to the practical requirements of the organization. In addition there will always be a need for some orientation training within the group itself. The domestic centre organized by the group undoubtedly constitutes the best venue for this type of training.

(*d*) It will not be possible to develop management talent to the full unless there is a proper system of screening and selection in operation. For this purpose a well-defined performance reporting routine must be integrated with a fully developed promotional control system.

(*e*) The most effective training of all is, however, that which can be done on the job itself. In the work situation people in any case usually tend to absorb ideas and practices from those with whom they are closely associated. By training top management—where all training should start—it becomes possible to influence the attitudes at all levels of management and to improve materially the quality of management practice throughout the organization.

(*f*) Finally, to give force and direction to these various developments it will be necessary to establish a strong and virile Institute of Management which would help in the co-ordination of research into management, stimulate thought, and provide a forum where current management issues might be discussed and resolved.

Trade Paragraphs

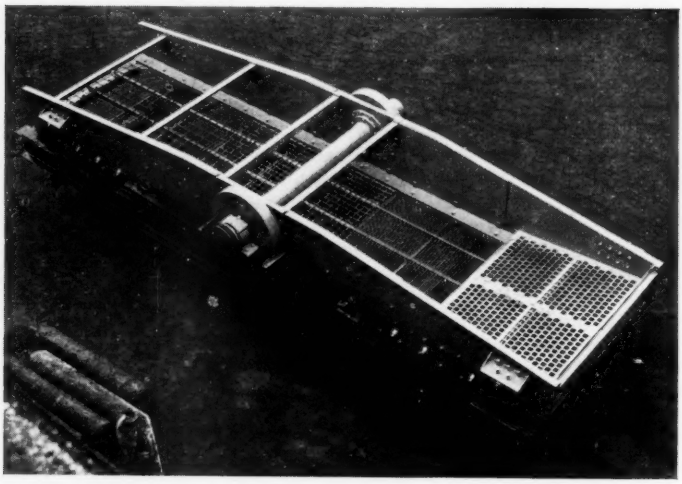
Stenberg Corporation AB, of Stockholm, manufacturers of the Flygt fully-submersible electric pumps, recently announced that the firm will be henceforth known as **Flygt International AB.**

William Rose, Ltd., of Brimsdown, Enfield, Middx., have produced a P.T.F.E. tape suitable for sealing threaded joints in pipes of all kinds. The tape is chemically inert and will resist attack by many corrosive substances.

Sturtevant Engineering Co., Ltd., of Southern House, Cannon Street, London, E.C. 4, in a new illustrated leaflet describe their cyclone dust collector which has many industrial applications, including those in the chemical and metallurgical industries.

Niagara Screens (Great Britain), Ltd., of Straysfield Road, Enfield, Middx., draw attention to a new addition to their range of vibrating screens, 5 ft. wide by 20 ft. long designed to discharge grades direct to bunkers without intermediate chutes or conveyors and as illustrated.

Niagara Type E12 Screen.



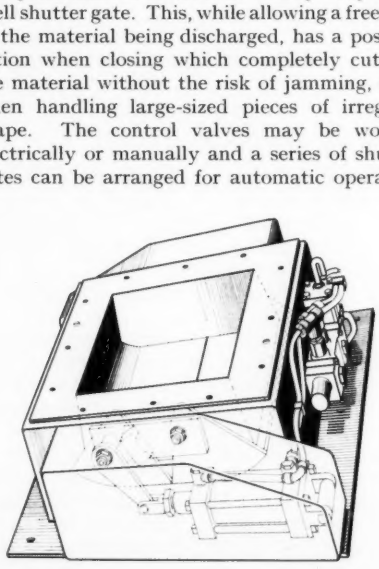
Atlas Copco AB, of Stockholm, Atlas Copco (Great Britain), Ltd., of Hemel Hempstead, Herts., have introduced a new range of tractor-

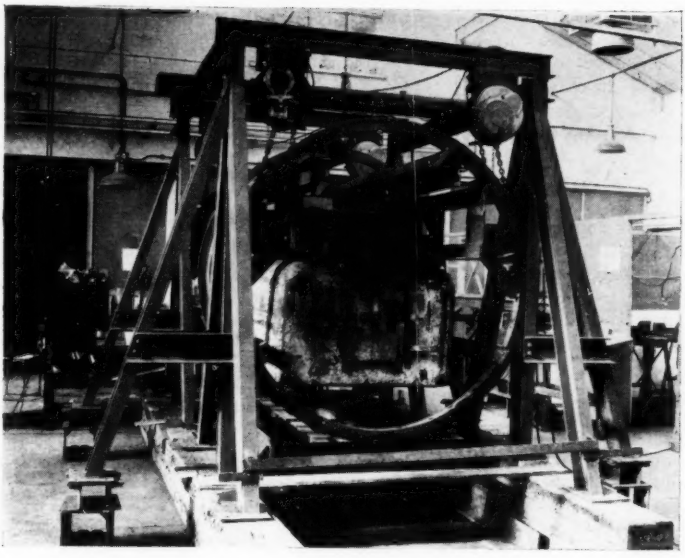
mounted compressors, as illustrated here, designed particularly for road construction in bad country.

Sinex Engineering Co., Ltd., of North Feltham Trading Estate, Feltham, Middx., in an illustrated leaflet describe their mine car shake-out unit, comprising a support frame in which is pivoted a tippler cage. By means of an electric vibrator carried in the beam structure the car can be vibrated at high frequency while inverted (see illustration).

Hadfields, Ltd., of Sheffield, announce that H.M.K. Sales, Ltd., of 3285 Cavendish Boulevard, Montreal, will in future, control and promote the marketing in the Dominion of all products of the group. The company recently issued a leaflet giving particulars of their die steels for a variety of forging, pressing, extrusion, and other processes.

Lindars Automation, Ltd., of 143, Maple Road, Surbiton, Surrey issue a note on a pneumatically-operated bin outlet for the control of heavy materials in the form of a heavy-duty clam-shell shutter gate. This, while allowing a free flow to the material being discharged, has a positive action when closing which completely cuts off the material without the risk of jamming, even when handling large-sized pieces of irregular shape. The control valves may be worked electrically or manually and a series of shutter gates can be arranged for automatic operation





Sinex Mine Car Shake-Out.

by remote control, if necessary, in a given sequence.

John Blackwood Hodge and Co., Ltd., of 25 Berkeley Square, London, W. 1, state that arrangements have been completed for the company to distribute the Leedsall dumper manufactured by **Robert Hudson, Ltd.,** of Leeds. The dumper trailer is of 5 cu. yd. struck capacity, is mounted to a heavy-duty Fordson Major tractor, and has been designed to withstand the roughest usage under all conditions. It was described and illustrated in the MAGAZINE for September last.

Fisher and Ludlow, Ltd., of 5, Bean Road, Tipton, Staffs, have issued advance information on their exhibits at the forthcoming British Trade Fair in Moscow. The main part of this will be a demonstration of their Flowmaster conveyor system, the principal application of which is to factory production lines, but they have included examples of Fisholow mining equipment. This calls attention to their Flexiroll hammock type troughing idlers mentioned in the MAGAZINE in June, 1959, in connexion with the Mining Machinery Exhibition in that year.

Electronic Instruments, Ltd., of Richmond, Surrey, have produced a fully coloured catalogue describing the complete range of pH meters they manufacture. Simultaneously with the pH meter development the company have devised and manufactured a range of electrodes using specially produced glasses. The direct reading pH meter Model 23A is the latest version of the original instrument developed in 1947 and has a feature which is the system of double temperature compensation, eliminating the need for corrections as changes occur in the temperature of the pH being measured.

Richard Sutcliffe, Ltd., of Horbury, Wakefield, have introduced a new type of tubular conveyor framework with cushion-

Sutcliffe Conveyor Framework.

mounted slung idlers designed to give resilience to the belt under differing load conditions. This arrangement allows the belt to form a deeper trough as the load increases thus decreasing the chance of spillage. An equally important advantage is that individual members can be easily and neatly packed to facilitate transport underground. The framework is the open type, has no cover sheets, and may be simply and speedily erected or dismantled. Up to and including 30-in. belt width the stools are at 10-ft. centres and the idlers at 5-ft. centres. For 36-in. and 42-in. belt widths the stool centres are 9 ft. and the idler centres 4 ft. 6 in.

Denver Equipment Co. of P.O. Box 5268, Denver, Colorado, (London office: 15–17 Christopher Street, E.C. 2), have published an 8-page bulletin, containing photographs and specifications of 44 different items of equipment for the mineral and chemical processing industries. Items include the SRL "Tru-Glandless" pump, which is designed for installations where dilution of pulp with sealing water is prohibited. The new laboratory flotation machine, which is described as three machines in one, being capable of performing many laboratory flotation tests in one machine that previously required three different units.

Shawnee Poole, Ltd., of Falcon House, Woodley, Reading, in some recent notes state that their system of earthmoving haulage has continued to find new European markets throughout 1960. A new example of its adaptability comes from a gypsum mine at Gagny, near Paris, where two rear-dump haulers have been put to work in the confined loading areas and narrow galleries underground. The proprietors of the mine report "considerable economy—with reduced cost of transport by 40% and improved output. Their ability to manoeuvre in the confined underground working areas has produced a much faster time cycle than with our previous vehicles."

Nordberg Manufacturing Co., of Milwaukee, Wisconsin (London office: 19 Curzon Street, W. 1), have introduced a new non-metallic backing for manganese-steel crusher parts. The new backing agent, called Nordbak, can be poured at room temperature and no special preparation of the wearing part or its mating member is necessary, mixing and pouring being done at the crushing site. Developed for Symons cone-crusher parts it has also been successfully used to back concaves and mantles in gyratory crushers and for ball-mill liners in wet grinding mills to improve seating of the mill liners and to prevent racing of the pulp against the shell.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

1157 of 1957 (857,856). DORR-OLIVER INC. Introduction of solids-carrying feed liquid into settling or clarifying apparatus.

33,987 of 1957 (858,295). H. STERN. Apparatus for the classification of materials or breaking down of agglomerates.

37,904 of 1957 (858,414). Winding drums for pithead winding equipment.

37,989 of 1957 (858,720). COMMERCIAL CASANOVA S.A. Fibro-cement moulding.

39,223 of 1957 (858,026). FULLER'S EARTH UNION, LTD. Manufacture of alumina.

29,793 of 1958 (857,956). GENERAL ELECTRIC CO., LTD. Production of tungsten powder.

3,918 of 1959 (858,989). J. CARNIE and E. CARNIE. Pneumatic separators.

6,922 of 1959 (858,644). R. P. MOORE. Liquid-solid separating apparatus.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Bergbaumechanck: Lehrbuch für bergmannische Lehranstalten. Handbuch für den praktischen Bergbau. (MAERCKS-OSTERMANN.) 6, vesbesserte Auflage. By W. OSTERMANN. Cloth, octavo, 616 pages, illustrated. Price DM 36. Berlin-Wilmersdorf: Springer-Verlag.

International Tin Research Council: Annual Report, 1960. Paper covers, 44 pages, illustrated. Greenford, Middlesex: Tin Research Institute.

Northern Rhodesia: Records of the Geological Survey, 1959. Paper covers, 79 pages, with 5 plates, and maps. Price 21s. Lusaka: Government Printer.

Bechuanaland Protectorate: Geological Survey Department Annual Report, 1959. Paper covers, 39 pages, with map. Price 2s. 6d. Lobatsi, Bechuanaland: Geological Survey.

British Borneo: Geological Report, 1959. By F. W. Roe. Cloth, large octavo, 219 pages, illustrated. Kuching, Sarawak: Geological Survey Department.

Engineer Buyers Guide, 1961. Paper covers, 984 pages. Price 10s. London: *The Engineer*.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

Gold, Position : *Prospects, Review.* World Gold Problems. F. R. JOUBIN, *Western Miner,* Jan., 1961.

Law. United States : *Rights, Mineral.* Mineral Rights. F. H. WEBER, Calif. Div. Mines *Mineral Inform. Service,* Feb., 1961.

†**Management, Mine :** *Trends, Training.* Trends in Management Training. G. F. JACOBS, *J. S. Afr. Inst. Min. Metall.,* Feb., 1961.

***Mining, Australia :** *Resources, Western.* Western Australia and Its Minerals. G. SPENCER-COMPTON, THE MINING MAGAZINE, Mar., 1961.

***Mining, Turkey :** *Resources, Production.* Mineral Activities in Turkey. W. DOMZALSKI, THE MINING MAGAZINE, Mar., 1961.

Production, Canada : *Mineral, B.C.* The Mineral Industries of British Columbia. F. H. STEPHENS, *Western Miner,* Jan., 1961.

Production, Canada : *Nickel, Arctic.* North Rankin Nickel Mines. G. J. R. HANNAH, *Precambrian,* Jan., 1961.

Production, Coal : *Mechanized, United Kingdom.* Statistics of Mechanized Output for the Year 1960. *N.C.B. Inform. Bull.* 61/221.

Production, United States : *Helium, Oklahoma.* Helium Production at the Bureau of Mines Keyes, Okla., Plant. W. M. DEATON, R. D. HAYNES, *Inform. Circ. U.S. Bur. Min.* 8018.

Production, United States : *Nickel, Oregon.* How Hanna Mines Lateritic Nickel Ore. J. R. BOGERT, *Min. World* (San Francisco), Feb., 1961.

***Production, United States :** *Pipes, Asbestos-Cement.* Asbestos-Cement Pipe Plant. A. HEGARTY, THE MINING MAGAZINE, Mar., 1961.

Resources, Canada : *Regions, Arctic.* Natural Resources Prospects of the Canadian Arctic. J. C. SPROULE, *Western Miner,* Jan., 1961.

†**Resources, Ceylon :** *Iron, Study.* The Geological Structure of the Dela-Noragolla Iron-Ore Field. D. J. A. C. HAPUARACHCHI, Gov. Miner. Report, 1959.

Resources, United Kingdom : *Coal, Lancashire.* Exploratory Boreholes in the Central Part of the South Lancashire Coalfield. D. MAGRAW, *Min. Engr.,* Mar., 1961.

Resources, United States : *Silicates, Aluminium.* Kyanite, Sillimanite, and Andalusite Deposits of the Southeastern States. G. H. ESPENSHADE, D. B. POTTER, *U.S. Geol. Surv. Prof. Paper* 336.

Uranium, Canada : *Industry, Survey.* A Survey of the Uranium Industry in Canada, 1959. J. W. GRIFFITH, *Canad. Mineral Inform. Bull.* MR 44.

Uranium, South Africa : *Industry, Survey.* South African Uranium—Past, Present, and Future. *S. Afr. Min. Engg. J.,* Feb. 3, 1961.

Geology

†**Economic, Ceylon :** *Iron, Dela-Noragolla.* The Geological Structure of the Dela-Noragolla Iron-Ore Field. D. J. A. C. HUAPARACHCHI, Gov. Miner. Report, 1959.

Economic, Porphyry : *Features, Productive.* Differences Between Barren and Productive Intrusive Porphyry. B. STRINGHAM, *Econ. Geol.,* Dec., 1960.

Iron Ore, Canada : *Genetics, Study.* Genetic Aspects of Michipicoten Iron Formations. A. M. GOODWIN, *Canad. Min. Metall. Bull.,* Jan., 1961.

***Ironstone, Freshwater :** *Oolites, Russia.* Oolitic Ironstones of Freshwater Origin. C. F. DAVIDSON, THE MINING MAGAZINE, Mar., 1961.

Regional, United States : *Coast Ranges, California.* Geologic Reconnaissance of the Northern Coast Ranges and Klamath Mountains, California. W. P. IRWIN, Calif. Div. Mines Bulletin 179.

Survey, Geophysics : *Mineral, Canada.* Target Mattagami (Quebec). R. H. PEMBERTON, *Canad. Min. Metall. Bull.,* Jan., 1961.

Survey, Geophysics : *Progress, Review.* Some Recent Developments in Geophysical Prospection. M. RICHARD, *Ann. Mines,* Feb., 1961.

Thucholite, Origin : *Study, Canada.* The Origin of Thucholite. H. R. HOEKSTRA, L. H. FUCHS, *Econ. Geol.,* Dec., 1960.

Metallurgy

General, Taconite : *Mining, Pelletizing.* How Reserve's Taconite Team Cuts Costs and Raises Pellet Output. *Min. World* (San Francisco), Feb., 1961.

Hydrometallurgy, Gold : *Exchange, Ion.* Ion Exchange for Gold Recovery. J. DAVISON and others, *Bull. Instn. Min. Metall.,* Feb., 1961.

Iron, Smelting : *Ores, Taconite.* Smelting Taconite in the Bureau of Mines Experimental Blast Furnace. M. B. ROYER and others, *Rep. Inv. U.S. Bur. Min.* 5724.

***Ore, Iron :** *Plant, Blending.* The Robins-Messiter System. Ore-Dressing Notes, THE MINING MAGAZINE, Mar., 1961.

†Shale, Aluminous : *Recovery, Alumina.* The Development of the Alum-Amine Process for the Recovery of Alumina from Shale. G. THOMAS, T. R. INGRAHAM, *Canad. J. Chem. Engg.*, Dec., 1960.

†Smelter, Copper : *Alaska, S. Rhodesia.* The Alaska Smelter. S. Rhod. Chamber of Mines *Journal*, Jan., 1961.

Uranium, Products : *Content, Rare-Earth.* The Determination of Total Rare Earths in High-Grade Uranium Products. R. J. GUEST, *Canad. Mines Branch Research Report* R67.

Uranium, Recovery : *Cells, Electrolytic.* A Study of Mercury-Cathode Membrane Cells for the Electrolytic Reduction of Uranyl Solutions. J. W. KIM, R. SIMARD, *Canad. Mines Branch Research Report* R70.

Machines, Materials

Crushers, Primary : *Design, Selection.* Primary Crusher Selection. L. R. MABSON, *Mine, Quarry Engg.*, Mar., 1961.

Explosives, Storage : *Effects, Properties.* Study of the Influence of the Storage Period of Explosives on Their Aptitude to Detonation. W. B. CYBULSKI, *Rev. l'Ind. Miner.*, Jan., 1961.

Recorder, Gas : *Use, Underground.* A Recorder of Atmospheric Methane Concentration Based on a Butane Flame Lamp. F. W. PRITCHARD, B. A. PHELPS, *Coll. Engg.*, Mar., 1961.

Steel, Properties : *Failure, Brittle.* Selection of Steels for the Avoidance of Brittle Failure. K. WINTERTON, *Canad. Mines Branch Inform. Circ.* K 120.

Timber, Treated : *Use, Sweden.* The Use of Impregnated Timber in the Swedish Mines. L. BIRKNER, *Rev. l'Ind. Miner.*, Jan., 1961.

Mining

Augering, Coal : *Practice, United States.* Augering in a Difficult Seam. A. HEGARTY, *Coll. Engg.*, Mar., 1961.

Breaking, Drilling : *Study, Percussive.* Wave Mechanics of Percussive Drilling. C. FAIRHURST, *Mine, Quarry Engg.*, Mar., 1961.

Breaking, U.S.S.R. : *Crusher, Electrohydraulic.* The Electrohydraulic Crusher. H. BERGSTROM, *Engg. Min. J.*, Feb., 1961.

General, Canada : *Nickel, Arctic.* North Rankin Nickel Mines. G. J. R. HANNAH, *Precambrian*, Jan., 1961.

General, France : *Methods, Review.* Metal Mines: Methods of Underground Exploitation. *Rev. l'Ind. Miner.*, No. Spec., Dec., 1960.

General, South Africa : *Fissure, Kimberlite.* Mining a Vertical Kimberlite Fissure at Star Diamonds Pty., Ltd. H. F. ALLAN, *J. S. Afr. Inst. Min. Metall.*, Jan., 1961.

General, United Kingdom : *Anhydrite, Cumberland.* Developments at Sandwith Anhydrite Mine. *Mine, Quarry Engg.*, Mar., 1961.

Handling, Conveyor : *Disposal, Waste.* Waste Disposal by Conveyors. *Mine, Quarry Engg.*, Mar., 1961.

Hazards, Gas : *Coal, United Kingdom.* The Application of an Air-Water Mixture to Prevent Ignitions of Firedamp in the Undercut. W. HISLOP, *Min. Engr.*, Mar., 1961.

Open-Cast, S. Rhodesia : *Tin, Kamativi.* Blasting Practice in Opencast Operations at Kamativi Tin Mines. S. DIJKSTRA, S. Rhod. *Chamber of Mines Journal*, Dec., 1960.

Supervision, South Africa : *Gold, Witwatersrand.* (1) Training of Supervisors in Mines of the General Mining and Finance Group. C. P. LINSELL, *J. S. Afr. Inst. Min. Metall.*, Jan., 1961. (2) Training of Officials in the Anglo-Transvaal Group. J. L. VAN EYSSEN, *J. S. Afr. Inst. Min. Metall.*, Feb., 1961.

***Tunnelling, United Kingdom :** *Drilling, Ladder.* Tunnel in the Highlands. THE MINING MAGAZINE Mar., 1961.

Ore Dressing

Cleaning, Coal : *Developments, Review.* Coal Dressing. M. POZZETTO, *Ann. Mines*, Feb., 1961.

Comminution, Grinding : *Mills, Ball.* Forum on "Ball Mills Using Steel *vs* Pebble Mills." H. L. AMES, J. M. HEMSTOCK, *Canad. Min. Metall. Bull.*, Jan., 1961.

Flotation, Theory : *Bubbles, Properties.* Theory of Flotation of Small and Medium-Size Bubbles. B. V. DERJAGUIN, S. S. DUKHIN, *Bull. Instn. Min. Metall.*, Feb., 1961.

General, Africa : *Recovery, Diamonds.* How New Methods and New Equipment Increase Diamond Recovery in Africa. A. F. DAILY, *Min. World* (San Francisco), Feb., 1961.

General, Canada : *Nickel, Arctic.* North Rankin Nickel Mines. G. J. R. HANNAH, *Precambrian*, Jan., 1961.

Gravity, Sink-Float : *Tin, T.B.E.* The Treatment of Tin Ores by the T.B.E. Process. J. E. F. MARSHALL, *T.B.E. Bull.*, Jan., 1961.

Iron, Canada : *Formation, Study.* Metamorphism in Iron Formations and Its Bearing on Beneficiation. G. A. GROSS, *Canad. Min. Metall. Bull.*, Jan., 1961.

Jigging, South Africa : *Diamonds, Kimberley.* Modification of a Diaphragm Jig to Treat Large Tonnages of Diamond-Bearing Kimberlite. R. G. WEAVIND, D. F. C. MCLACHLAN, *J. S. Afr. Inst. Min. Metall.*, Jan., 1961.